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EFFECT OF TIME AND TEMPERATURE ON ACCELERATED CHEMICAL DURABILITY TESTS MADE ON COMMERCIAL GLASS BOTTLES*

By Frank R. Bacon and O. G. Burch

Abstract

Chemical durability results obtained by tests on crushed samples and bottle surfaces on a variety of commercial glass-bottle compositions show the difficulties encountered in attempting to correlate accelerated tests with the actual performance of the bottles toward various solutions under service conditions. The results obtained thus far indicate that the value of accelerated tests conducted with distilled water as a leaching medium is questionable as an aid in predicting resistance of various glass compositions to neutral solutions at room temperature.

I. Introduction

Manufacturers as well as users of glass containers desire some assurance that the containers they make or use possess (*a*) good resistance to the action of weather during the storage of empty containers in warehouses and (*b*) adequate resistance to the action of acidic, neutral, or alkaline solutions which might be packaged in the containers.

The manufacturer of soda-lime glass containers is in a rather favorable position, in respect to the required resistance to various solutions which might be packaged in glass, because at least 90% of the glass products sold are acidic. The resistance of a soda-lime glass to the action of an acidic solution furthermore is considerably greater than its resistance to an alkaline solution. Milk, carbonated beverages, whiskey, beer, practically all food products, and about 90% of all medicinal solutions are acidic. Among the neutral or alkaline solutions packaged in glass are gin, some mineral waters, milk of magnesia, sodium hypochlorite, aqua ammonia, and a few miscellaneous medicinal and proprietary preparations.

To measure or test the resistance of various possible bottle-glass compositions to the action of different types of solutions which might be packaged in glass under conditions similar to those of commercial use would be an almost insurmountable task and would require many years of study. To reduce this long time factor, both the manufacturers and the users of glass containers have resorted to accelerated durability or resistance tests which may be carried out in periods of one to twenty-four hours at high temperatures. The results obtained by such accelerated tests are interpreted in terms of the resistance of the various glasses to different solutions under conditions of commercial use, viz., at room temperature. This paper points out some of the obstacles confronting these interpretations.

The accelerated or high-temperature durability tests, more or less in general use, may be classified as follows: (1) a sample consisting of (*a*) glass grains or (*b*) the finished glass article, such as a container and (2) the type of leaching medium used, viz., (*a*) distilled water, (*b*) a dilute acid, or (*c*) a dilute alkaline solution.

The standard chemical-durability test methods used in England[1] and Germany[2] entail leaching definite amounts of glass grains of specified size with distilled water at 100°C. Burch[3] has proposed a method to determine the chemical durability of soda-lime glasses. He has also reviewed various methods[4] which were used to determine the durability of soda-lime glasses, and he has attempted to point out some of the advantages of the crushed-sample or glass-grain methods. The method proposed was subsequently tried, as The American Ceramic Society method No. 1, by a number of coöperating investigators.[5] Taylor and Smith,[6] investigating the applicability of this method to glasses other than soda-lime glasses, concluded that it is unsatisfactory as a test either for lead or for borosilicate compositions.

Those who have worked on the subject of the chemical durability of glass generally have recognized that acidic solutions (except hydrofluoric acid) have considerably less corrosive effect on glass than do the alkaline solutions. An increase in the hydrogen-ion concentration or in acidity of an acid solution, furthermore, has no effect on the rate of attack of glass by this type of solution. There is plenty of evidence, however, that an increase in hydroxyl-ion concentration or an increase in basicity of the solution in alkaline solutions is followed by a considerable increase in the rate of glass corrosion by the solution. Botvinkin

* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 19, 1939 (Glass Division). Received April 19, 1939.

[1] Violet Dimbleby and W. E. S. Turner, "Relation Between Chemical Composition and Resistance of Glasses to Action of Chemical Reagents: Part I," *Jour. Soc. Glass Tech.*, **10** [39] 304–58 (1926); *Ceram. Abs.*, **6** [3] 98 (1927).

[2] M. Thomas, "Determination of Durability of Glass by Powder Method," *Jour. Soc. Glass Tech.*, **12**, 87–92 (1928).

[3] O. G. Burch, "Development of a Reliable Method for the Determination of Solubility of Soda-Lime Glasses," *Bull. Amer. Ceram. Soc.*, **13** [8] 200–204 (1934).

[4] O. G. Burch, "Methods for Determining Chemical Durability of Soda-Lime Glasses," *ibid.*, **15** [5] 175–81 (1936).

[5] "Report of Committee on Chemical Durability of Glass," *ibid.*, **14** [5] 181–84 (1935).

[6] W. C. Taylor and R. D. Smith, "Solubility Characteristics of Glasses Basically Different in Composition," *Jour. Amer. Ceram. Soc.*, **19** [11] 331–35 (1936).

and Tanchilevich[7] have confirmed these points relating to acidic and alkaline solutions.

About 90% of all the published data on chemical durability has been obtained in tests in which the leaching solution was initially distilled water. Distilled water has been used presumably because it is (*a*) essentially neutral and (*b*) a convenient medium with which to work. When distilled water is used as a leaching medium in a durability test, however, it becomes an alkaline solution as soon as it extracts any alkali from the glass surface. The concentration of this alkaline solution, furthermore, increases during the test at a rate which depends not only on the initial tendency of the glass surface to give up alkali to a neutral solution but also on the degree to which the glass surface is disintegrated by a solution constantly increasing in degree of alkalinity. In attempting to run accelerated durability tests on glass with distilled water, the existence of variables other than time, temperature, and the glass area exposed must therefore be recognized.

II. Experimental Results

The test data presented here were obtained as part of an extensive program designed to determine the relationship, if any such exists, between accelerated durability tests conducted on (1) crushed glass samples or glass grains and (2) inside surfaces of glass bottles using (*a*) dilute acid, (*b*) distilled water, and (*c*) *N*/50 sodium-hydroxide solution as leaching media and on the resistance of the same glass bottles to various solutions at room temperature. The tests have not progressed sufficiently far to prove or disprove definitely whether accelerated tests at high temperatures may be interpreted in terms of resistance at room temperature. They have progressed sufficiently, however, to show a number of difficulties involved in attempting to interpret the results obtained at comparatively high temperatures with those at somewhat lower temperatures.

The bottles tested were obtained from factories of various glass-container manufacturers, with the approximate date of their manufacture. Ten of the compositions were round 4-ounce bottles, commonly referred to in the trade as "Boston round." Bottle "E" was also of 4-oz. capacity but it was oval. The inside surface area of the round bottles was approximately 156 sq. cm. and that of the oval bottle, "E," about 168 sq. cm. No adjustment was made in the results to compensate for this difference in glass area.

The chemical compositions of the glasses represent a fairly good cross section of the container-glass compositions used in this country. The alkali-oxide contents varied from 14.5 to 16.5%; the alumina contents varied from 0.5 to 3.0%; and the dibasic oxide contents from approximately 8.0 to 11.5%. Calcite-lime and dolomite-lime glasses are represented in this group.

[7] O. K. Botvinkin and A. M. Tanchilevich, "Relation Between Resistance of Glass to Alkalis and Acids and Concentration in Hydrogen Ions," *Z. anorg. allgem. Chem.*, **168,** 356–60 (1928); *Ceram. Abs.*, **8** [9] 647 (1929).

Table I gives the date of manufacture of the various lots of bottles and comments on their condition when the tests were begun.

TABLE I

IDENTIFICATION OF BOTTLES

Bottle	Date of manufacture	Remarks
A	October, 1938	
B	December, 1938	
C	1938	
D	December, 1938	
E	October, 1938	Oval shape (8% more area)
F	January, 1939	
G	1938	
H	October, 1938	Weathered
I	January, 1939	
J	June, 1938	Weathered
K	December, 1938	

The results in Table II were obtained by (1) The American Ceramic Society method No. 1, which calls for the treatment of a 10-gram crushed sample of 40- to 50-mesh screen size (0.417 to 0.295 mm.) in 50 cc. of *N*/50 H_2SO_4 for four hours at 90 ±0.5°C, followed by back titration and calculation of the alkali extracted as percentage of Na_2O, and (2) a modification in which previously boiled distilled water was used as the leaching medium. The solutions were titrated to a methyl red end point in both tests.

TABLE II

ALKALI EXTRACTION DATA ON CRUSHED SAMPLES

Na_2O (%)

Bottle	Attacking medium: *N*/50 H_2SO_4	Attacking medium: Water
A	0.051, 0.054	0.040, 0.040
B	.027, .029	.037, .036
C	.053, .054	.050, .050
D	.035, .036	.035, .035
E	.030, .031	.027, .027
F	.062, .063	.056, .055
G	.029, .030	.042, .041
H	.058, .058	.061, .061
I	.080, .079	.066, .069
J	.061, .061	.061, .059
K	.030, .033	.051, .051

Tables III to VII, inclusive, show the results obtained in tests with actual bottles. The bottles were rinsed twice with tap water, twice with hot distilled water, and were filled to their rated capacity (118 cc.) with the attacking medium. The filled bottles were capped with closures equipped with black alkali-resistant liners and were immersed in a water bath at the temperatures and for the periods specified in the table headings. They were then removed, cooled to room temperature, and the extracted material was determined. The water baths were controlled within ±1°C.

The results obtained with 0.0085 *N* sulfuric acid as the attacking medium are presented in Table III. The alkali extracted by this acid was determined by back titration with *N*/50 sodium hydroxide to the methyl red end point, and it was calculated as milligrams NaOH per liter of solution.

Table IV gives the results obtained with previously boiled distilled water as the attacking medium. The alkali extracted was determined by direct titration with $N/50$ sulfuric acid to the methyl red end point, and it was calculated as milligrams of NaOH per liter of solution. The tests run at 121° and 130°C were conducted in an autoclave, the bottles being filled to rated capacity and loosely capped. Loss through the loose closures averaged about 3 cc. for each bottle, and the results therefore were calculated on the basis of 115 cc.

TABLE III

ALKALI EXTRACTION BY 0.0085 *N* ACID

	Mg.NaOH/liter					
Temp., °C.	75	75	75	95	95	95
Time	7 days	14 days	35 days	4 hr.	12 hr.	24 hr.
Bottle						
A	15	23	43	9	12	18
	14	23	41	10	14	18
B	2	5	22	2	3	4
	2	5	21	3	4	5
C	11	26	50	7	10	15
	11	23	51	8	11	15
D	7	11	24	5	7	9
	6	12	18	5	7	9
E	7	14	19	4	6	9
	7	13	21	4	6	9
F	15	27	47	9	13	18
	16	24	55	9	14	18
G	5	8	24	4	5	8
	5	9	18	4	5	6
H	15	19	29	8	11	16
	16	20	29	8	11	16
I	26	36	Broke	14	20	29
	26	35	Broke	14	20	28
J	18	23	31	9	12	17
	18	22	31	9	13	17
K	5	10	22	4	5	10
		10	24	5	6	7

Table V gives the results obtained with $N/50$ sodium-hydroxide solution as the attacking medium. The alkali extracted in the course of the tests was determined by titration with $N/50$ sulfuric acid to the methyl red end point. From the difference between this titer and that of a 118-cc. blank, the alkali extracted was calculated as milligrams NaOH per liter.

Table VI shows a comparison of results obtained on a 24-hour test at 95°C on the various bottles, when the attacking media used were (*a*) 0.0085 *N* H_2SO_4, (*b*) distilled water, and (*c*) a buffer solution, 0.0191 *N* in boric acid (H_3BO_3) and 0.000251 *N* in borax ($Na_2B_4O_7$). This buffer solution has an initial pH of approximately 7.5, and, in the least durable bottles tested, the pH increased only to 7.7 during 24 hours at 95°C. The solution, therefore, is slightly alkaline during the test period.

The alkali extracted in the buffer test was determined by titration with $N/50$ sulfuric acid to the methyl red end point. Because methyl red is not affected by the presence of borate ions, this titration may be made with precision. From the difference between this titer and that of a 118-cc. blank, the alkali extracted was calculated as milligrams NaOH per liter.

Table VII shows a comparison of volumetric and gravimetric results obtained on the bottles when both dilute acid and distilled water were used as leaching media. The gravimetric results were determined by evaporating the entire contents of the solutions to dryness in platinum and igniting to constant weight. In the distilled-water tests run by this method, a small amount of sulfuric acid was added to each solution at the beginning of the evaporation to convert all of the basic oxides to sulfates.

TABLE IV

ALKALI EXTRACTION BY WATER

	Mg.NaOH/liter*															
Temp., °C.	50	50	50	50	75	75	75	75	75	95	95	95	121	121	121	130
Time	14 days	21 days	35 days	70 days	1 day	3 days	7 days	14 days	35 days	4 hr.	12 hr.	24 hr.	1 hr.	3 hr.	5 hr.	5 hr.
Bottle																
A	12	14	15	22	11	22	29	39	53	12	24	30	18	33	41	58
	12	14	19	24	9	20	29	39	55	12	22	31	18	33	41	58
B	4	7	9	12	3	8	17	43F	71F	3	10	14	6	18F	27F	57F
	4	7	10	14F	3	9	17	43F	81F	3	11	15	7	18F	30F	57F
C	8	13	16F	20	9	15	24F	49F	68F	9	21F	24F	14F	27F	37F	61F
	7	13	16F	17	9	16	24F	45F	75F	9	20F	28F	13F	27F	39F	59F
D	6	9	12	15F	6	12	19	30F	43F	6	13F	19F	10	23F	28F	47F
	6	9	13	16F	6	11	18	30F	44F	7	14F	18F	10	20F	27F	46F
E	7	9	12	17	7	14	20	28	33	7	14	22	13	24	29	49F
	7	9	12	16	6	14	20	29	36	7	14	22	13	24	28	50F
F	15	16	19	28	14	26	39	49F	64F	14	27	43	23F	42F	55F	81F
	14	18	21	29	14	26	38	49F	66F	14	27	43	22F	42F	56F	81F
G	9	11	15F	20F	7	15	54F	73F	111F	7F	17F	28F	14F	42F	56F	82F
	9	11	16	21F	7	15	52F	75F	109F	7F	17F	28F	13F	41F	57F	84F
H	12	16	20F	44F	12	23F	58F	73F	91F	11	22F	50F	19F	49F	64F	95F
	12	16	20	47F	12	23F	60F	73F	90F	11	22F	50F	18F	48F	65F	93F
I	18F	22F	28F	33F	18	28F	46F	58F	Broke	18F	26F	38F	26F	43F	54F	75F
	19F	22F	27F	33F	18	28F	45F	60F	Broke	18F	27F	38F	26F	42F	54F	75F
J	12F	14	16F	30F	11F	20F	52F	68F	81F	12F	20F	47F	18F	45F	62F	94F
	12F	15	16F	29F	10F	20F	53F	68F	82F	12F	21F	46F	19F	46F	61F	93F
K	12	17F	18F	27F	11	31F	110F	128F	146F	10F	26F	81F	22F	79F	96F	116F
	13	18F	22F	28F	10	30F	110F	122F	149F	10F	26F	81F	23F	83F	98F	116F

* Symbol F following any numerical value indicates presence of flakes or spicules in solution.

III. Discussion of Results

(1) Dilute Acid Tests

The results of the acid tests conducted at 75°C are shown in Fig. 1. The curves proceed in a fairly uniform manner as time is increased, except the curve representing bottle B. The sudden increase in rate of attack on bottle B, as shown in the difference in results obtained at 14 days and 35 days, is inexplicable at the present time. Although good checks were obtained on duplicate bottles in the 35-day test for bottle B, the results shown for that period are probably in error.

Figure 2 shows the results obtained in dilute acid tests on the various bottles at a temperature of 95°C.

TABLE V

ALKALI EXTRACTION BY 0.02 *N* NaOH

Mg.NaOH/liter*

Temp., °C	24–29	75	75	75	75	75	95	95	95	95
Time	59 days	1 day	3 days	7 days	14 days	35 days	1 hr.	4 hr.	12 hr.	24 hr.
Bottle										
A	17	43F	62F	160F	230F	260F	19	36F	47F	81F
	17						22	37F	45F	71F
B	37F	59F	125F	200F	270F	350F	25F	57F	90F	132F
							26F	55F	90F	138F
C	35F	69F	135F	220F	300F	350F	28F	61F	104F	159F
							27F	62F	102F	153F
D	32F	64F	125F	180F	260F	290F	25F	56F	92F	139F
							25F	57F	92F	136F
E	36F	56F	110F	160F	190F	220F	31	46F	79F	139F
							31	48F	79F	129F
F	37F	56F	115F	200F	270F	340F	24	44F	75F	132F
							24	48F	79F	129F
G	43F	68F	165F	250F	340F	430F	28F	60F	108F	173F
							28F	60F	106F	173F
H	45F	77F	180F	280F	370F	450F	28F	64F	125F	193F
							26F	64F	125F	200F
I	43F	77F	160F	240F	Broke	Broke	31F	65F	116F	183F
							31F	65F	117F	183F
J	47F	77F	175F	280F	360F	460F	31F	62F	123F	200F
							28F	62F	122F	200F
K	49F	71F	150F	240F	330F	470F	29F	60F	99F	144F
							29F	62F	98F	144F

* Symbol F following any numerical value indicates presence of flakes or spicules in solution.

TABLE VI

COMPARISON OF ALKALI EXTRACTION AT 95°C BY ACID,* BUFFER,† AND WATER‡

Mg.NaOH/liter

Time (hr.)	4	4	4	12	12	12	24	24	24
Attacking medium	Acid	Buffer	Water	Acid	Buffer	Water	Acid	Buffer	Water
Bottle									
A	9	7	12	12	12	24	18	16	30
	10	7	12	14	11	22	18	15	31
B	2	3	3	3	4	10	4	5	14
	3	3	3	4		11	5		15
C	7	6	9	10	10	21F	15	12	24F
	8	6	9	11	9	20F	15	14	28F
D	5	4	6	7	6	13F	9	9	19F
	5	4	7	7	7	14F	9	9	18F
E	4	5	7	6	7	14	9	9	22
	4	4	7	6	7	14	9	9	22
F	9	9	14	13	13	27	18	17	43
	9	8	14	14	13	27	18	18	43
G	4	4	7F	5	6	17F	8	9	28F
	4	4	7F	5	6	17F	6	9	28F
H	8	7	11	11	12	22F	16	18	50F
	8	8	11	11	13	22F	16	18	50F
I	14	15	18F	20	20	26F	29	28	38F
	14	15	18F	20	20	27F	28	28	38F
J	9	9	12F	12	14	20F	17	18	47F
	9	9	12F	13	13	21F	17	18	46F
K	4	5	10F	5	7	26F	10	12	81F
	5	5	10F	6	7	26F	7	12	81F

* Acid, 0.0085 *N* H_2SO_4.

† Borax-boric acid buffer (see composition p. 3) had an initial pH of 7.5 and not exceeding pH 7.7 at the conclusion of any test.

‡ Symbol F following any numerical value indicates presence of flakes or spicules in solution.

The curves for each bottle proceed in an orderly and expected manner as time is increased.

A comparison of results obtained by crushed sample tests with dilute acid (Table II) with those obtained on the inside bottle surfaces at various times and temperatures (Table III) shows that (*a*) by both types of test, bottles B, D, E, G, and K are the most resistant and bottle I is the least resistant; (*b*) as judged by crushed-sample tests, bottles A and C appear to be more resistant than bottles F, H, and J; (*c*) tests conducted for periods as long as 24 hours at 95°C do not distinguish between the resistance to acids of bottles A, C, F, H, and J; (*d*) tests conducted at 75°C for long periods of time, bottles H and J appear to show definitely better resistance than bottles A, C, and F; at some period between 7 and 35 days, and at 75°C, the order of resistance to dilute acid of bottles A and C appears to reverse itself, i.e., bottle C, which was superior to bottle A at the end of 7 days, seems to be inferior to it at the end of 35 days; and (*e*) the greatest and possibly the only real discrepancy, when crushed-sample tests with dilute acid are compared with tests on the inside surfaces of bottles conducted with dilute acid, appears to be the failure of surface tests to rank bottles H and J in the same order in relation to bottles A, C, and F as do the crushed-sample tests.

As noted in Table I, bottles H and J showed visible weathering on their surfaces when they were received. The rinsing to which all bottles were subjected in tests conducted on bottle surfaces may have removed some of the alkali present as weathering products on the surfaces of these two bottles. It is not unusual for weathered bottles, when rinsed, to be more resistant than new bottles of the same composition and subjected to the same rinsing and test procedure.

Sufficient data have not yet been obtained to permit an interpretation of results in accelerated dilute acid tests on any single bottle in terms of the resistance of the same glass to the same acidic solution at room temperature. Tests now under way at room temperature probably will permit some interpretation along this line within a year or two.

If bottles H and J are disregarded in the dilute acid tests because they were weathered when tested, no great discrepancy exists between the results obtained on crushed-sample tests and those obtained on inside bottle surfaces.

From the data thus far obtained, there is no conclusive evidence that accelerated tests conducted with dilute acid either on glass grains or bottle surfaces will not rank bottles in the same order of resistance to acidic solutions as their resistance to the same type of solutions at room temperature.

A crushed-sample method or a method whereby the inside surface of a bottle is exposed to dilute acid gives fairly reproducible results. The inherent advantages, however, of a crushed-sample method for measuring the resistance of glass as glass to acidic solutions, remain as they have always been, viz., (*a*) a large and constant area of glass surface may be exposed which permits the test to be run for a fairly short period of time and yet obtains a sufficient amount of leached alkali for accurate determination; (*b*) bottles of the same relative size and shape cannot always be obtained for comparing the resistance of two glass compositions; the measurement of the exposed area, if actual bottles are to be used, is a quite difficult task; and (*c*) no knowledge of the previous history of the glass is necessary; conditions and time of storage may radically affect the results obtained on the inside surface of a glass bottle.

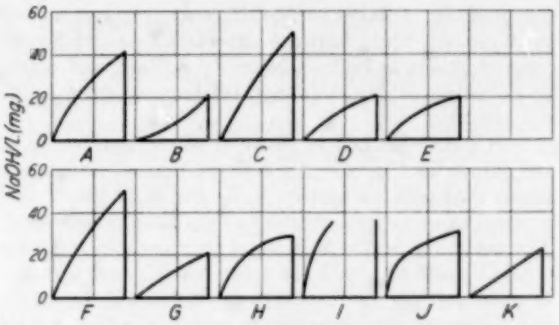

FIG. 1.—Attack by 0.0085 *N* acid vs. time at 75°C; total time, 35 days.

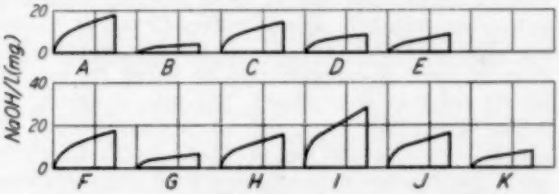

FIG. 2.—Attack by 0.0085 *N* acid vs. time at 95°C; total time, 24 hr.

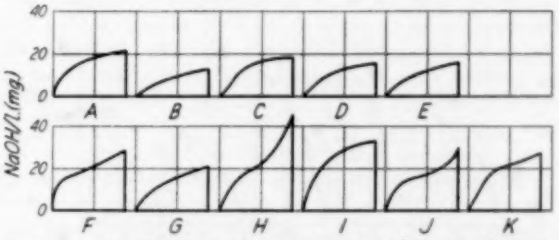

FIG. 3.—Attack by water vs. time at 50°C; total time, 70 days.

(2) Distilled Water Tests

The results of tests conducted on bottles with distilled water as the leaching medium at 50°C are shown in Fig. 3. All of the curves, except those for bottles H and J, appear to proceed in an orderly and expected manner as the time is increased. Bottles H and J seem to show distinct breaks or increases in rate of attack at an NaOH concentration slightly in excess of 20 mg. per liter.

An examination of Table IV indicates that there is no absolute relation between the tendency of all the glasses to develop flakes and the alkali concentration of the solution; e.g., in the 50°C tests, bottle J shows

the presence of flakes at NaOH concentrations as low as 12 mg. per liter; bottle A shows no flakes at NaOH concentrations as high as 24 mg. per liter; and bottle F, no flakes at NaOH concentrations as great as 29 mg. per liter.

Test data obtained in distilled water tests at 75°C are shown in Fig. 4. An examination of this figure shows that only on bottles A, E, and F do the results proceed in an orderly manner as the time is increased. The curve for bottle B shows a sharp break, or an increase in rate of attack, at some NaOH concentration near 30 mg. per liter; curves for bottles C, D, G, H, and J show noticeable breaks in rate of attack at NaOH concentrations near 20 to 30 mg. per liter. The rate of attack on these bottles at high alkali concentrations varies considerably; that on bottle D begins to slacken at a concentration of approximately 40 mg. of NaOH per liter; and that on bottle J shows no appreciable decrease until a concentration of about 70 mg. of NaOH per liter is reached. The rate of attack on bottle G remains quite high at a concentration of NaOH in excess of 100 mg. per liter. Bottle K, which has a fair resistance to solutions with concentrations up to 10 mg. of NaOH per liter (evident in Fig. 3), shows a rapid increase in rate of attack at concentrations of NaOH between 30 and 110 mg. per liter; at the latter point, however, the rate begins to slow down somewhat. To locate the pronounced breaks accurately in the rate of attack on bottles B, C, G, H, J, and K probably would necessitate running tests at 75°C at intermediate times between those for which values are shown.

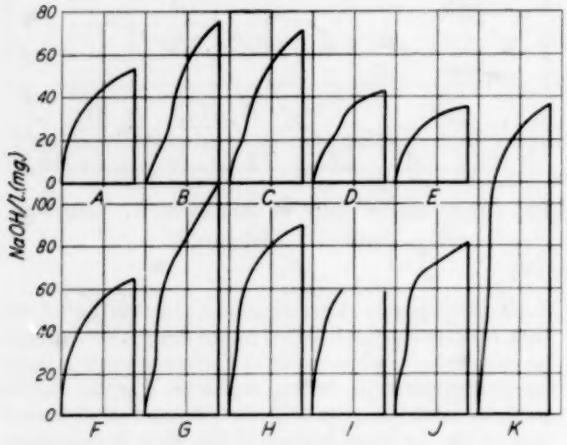

FIG. 4.—Attack by water vs. time at 75°C; total time, 35 days.

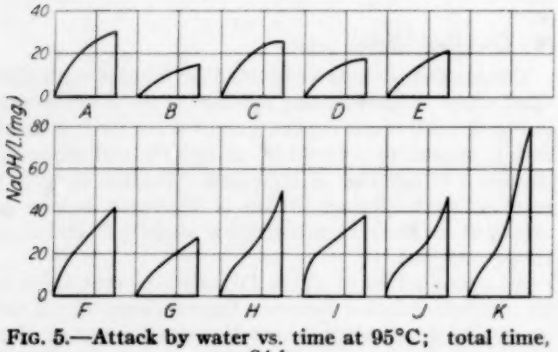

FIG. 5.—Attack by water vs. time at 95°C; total time, 24 hr.

The results obtained in tests at 75°C with distilled water as the leaching medium probably mean little or nothing in judging the resistance of a bottle to the action of distilled water at room temperature. All that has really been determined in the tests is the rate of attack on bottles of various glass compositions by solutions, the alkalinity of which increases at a different variable rate for each individual composition.

As in the tests at 50°C, there is no definite relation between the amount of alkali extracted from the glass and the tendency of the solution in the bottle to show flakes or spicules; e.g., bottle A shows no flakes at an NaOH concentration of 55 mg. per liter, whereas bottle J, in one instance, shows flakes at a concentration of 10 mg. of NaOH per liter.

Distilled-water test results, conducted at 95°C, are shown in Fig. 5. The progression of the rate of attack proceeds fairly uniformly as time is increased for all bottles except H, J, and K, although the rate of attack varies somewhat between the individual bottles. The curves for bottles H, J, and K show breaks more or less pronounced, indicating that at certain alkali concentrations (depending upon the individual glass) the rate of attack increases considerably. The break in the curve for bottle H seems to occur at approximately the same NaOH concentration that it did in the 50° and 75° tests. The breaks in the curves for bottles J and K seem to occur approximately at the same alkali concentrations as in the 75° tests.

At a temperature of 95°C, there is no consistent relationship between the alkali concentration of the solution and the formation of flakes, which holds for all glasses. Bottle A, for example, shows no flakes at a NaOH concentration as great as 30 mg. per liter, whereas bottles G and K show flakes at NaOH concentrations of 10 or fewer milligrams per liter.

The results of distilled water tests conducted at temperatures of 121° and 130°C are shown in Table IV. Figure 6 shows the results of the tests at 121°. The concentrations at which breaks in rates of attack occur on the various glasses are not readily seen because the curves have been drawn as the best possible curves obtainable from the experimental data. To locate the points of break accurately for bottles G, H, J, and K would probably have necessitated tests run for two hours.

If, with the data at the various times and temperatures for the distilled-water tests, an attempt is made to correlate the results obtained under one test condition in terms of those obtained under a different test condition, considerable difficulty is encountered. Test values for one hour at 121°, for example, are obtained at times varying between 8 and 12 hours (depending upon the bottle) at 95°; at times varying between two and three days at 75°; and at times varying between 22 and 46 days at 50°.

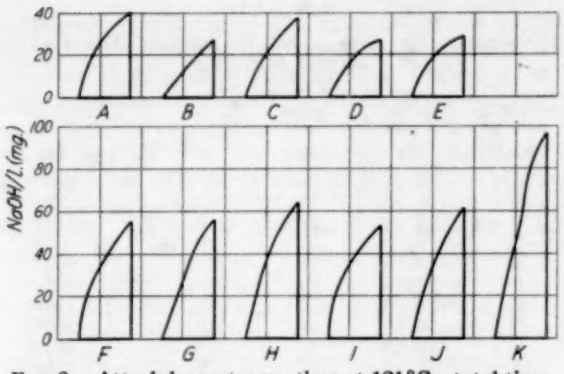

FIG. 6.—Attack by water vs. time at 121°C; total time, 5 hr.

If these values obtained at 121° in a period of three hours are compared with those obtained at the various lower temperatures, bottles C, F, H, J, and K at 95°C show approximately the same values in 24 hours as those obtained on similar bottles in three hours at 121°C. For all other bottles, however, the values obtained in three hours at 121°C are greater than those obtained in 24 hours at 95°C. At 75°C, values equivalent to those obtained in three hours at 121°C are obtained in periods varying from three to ten days, depending upon the glass composition. At 50°C, values obtained in 70 days are less for every bottle than those obtained in three hours at 121°. For bottles B, C, D, E, and H, values obtained in 70 days at 50° are only slightly less than those obtained in three hours at 121°, but bottle G shows approximately only one half the NaOH extracted in 70 days at 50° as it does in three hours at 121°, and bottle K shows approximately one third as much extracted in 70 days at 50° as in three hours at 121°.

In view of these inconsistencies in the relation between the accelerated tests with distilled water at 95° and 121°C and tests at 50°C, attempts to relate accelerated test results with distilled water to those conducted at room temperature appear just about hopeless. An examination of the curves (Figs. 3, 4, 5, and 6) for the various bottles in the distilled water tests should indicate that there is no reasonable expectation that these accelerated distilled water tests should parallel resistances of the glasses to distilled water at room temperature. Curves for bottles B and K (Fig. 5), for example, show that after a period of 12 hours the concentration of NaOH in the solution acting on bottle B varies from 10 to 15 mg. per liter and that acting on bottle K during the same period varies from 26 to 81 mg. per liter. During this period (from 12 to 24 hours), both solutions are alkaline (not distilled water), and the solution contained in bottle K is considerably more alkaline than that in bottle B.

When further test data are obtained on the storage of distilled water at room temperature, a relationship conceivably may be established between these data and some accelerated test (e.g., two or three hours at 95°C). The probability of being able to do this, however, is remote, to say the least.

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In the distilled water tests conducted on the inside surfaces of bottles, no absolute relationship is seen (even for any single bottle) between the alkali concentration of the solution and the tendency to form flakes or spicules; for example, (*a*) at bottle C 121°C shows flakes at a NaOH concentration as low as 13 mg. per liter, but at 50°C there are no flakes at NaOH concentrations in excess of 17 mg. per liter; (*b*) at 95°C, bottle D shows flakes at 13 mg. NaOH per liter, but at 75° there are no flakes at 18 mg. NaOH per liter; (*c*) at 121°C, bottle F shows flakes at 23 mg. NaOH per liter; at 50°C, it shows no flakes at 28 mg. NaOH per liter; and at 75°C, no flakes at 39 mg. NaOH per liter; (*d*) bottle G shows flakes at 95°C at a concentration of 7 mg. NaOH per liter, but at 75°C it shows no flakes at 15 mg. NaOH per liter.

This failure of some bottles to show flakes at the lower temperatures may possibly be due to the tendency of the flakes to redissolve after being formed. An examination of the results shown in Table IV for tests at 50°C, for example, indicates that bottle J showed flakes present after a period of 14 days at a NaOH concentration of 12 mg. per liter, but no flakes were evident in 21 days at a NaOH concentration of 15 mg. per liter.

A comparison of results in Table II with those of Table IV indicates that there is no relation between the results obtained on crushed samples and those on the inside surfaces of bottles, using the same attacking medium in both instances. There is no reason why there should be any relation on this point because all the tests with distilled water, whether they were conducted on bottle surfaces or on a crushed sample, in reality measure only the resistance of the glass to an alkaline solution, the concentration of which is increasing at a different rate for every glass composition tested. The ratio of the glass area exposed to the volume of solution used is considerably greater in the crushed-sample tests than in those tests conducted on the inside surfaces of the bottles. The alkaline concentration of the solution in the crushed-sample tests would naturally be expected to increase at a considerably faster rate than it does in tests on the inside surfaces of the bottles. This actually happens, of course, as shown by the results; for example, the concentration of alkali in the crushed-sample test with distilled water on bottle K is equivalent approximately to 128 mg. NaOH per liter at the end of four hours at 90°C. At the end of the same period in a test at 95°C conducted on the inside surface of the bottle, this concentration is only 10 mg. per liter

(3) Sodium Hydroxide Tests

The results obtained with *N*/50 sodium hydroxide on the various glasses at 75°C are shown in Fig. 7; those obtained with the same attacking medium at 95°C are shown in Fig. 8. An examination of these two figures reveals that as far as dissolved alkali from the glass surface is concerned, the attack by *N*/50 NaOH is considerably greater on all glasses than the attack either by distilled water or by dilute acid. This fact has been illustrated numerous times.

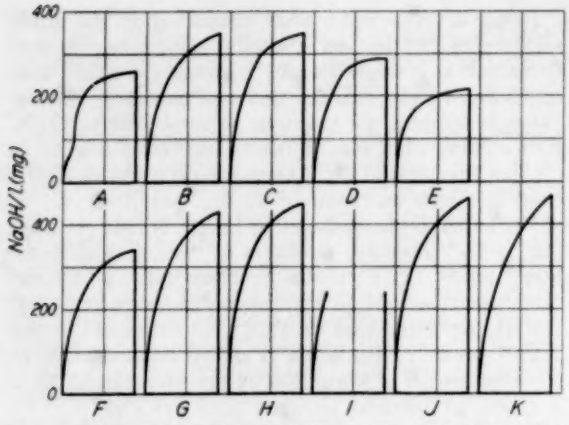

FIG. 7.—Attack by 0.02 *N* NaOH vs. time at 75°C; total time, 35 days.

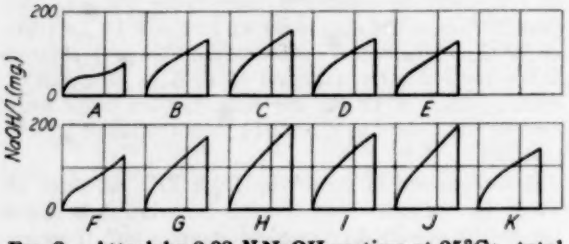

FIG. 8.—Attack by 0.02 *N* NaOH vs. time at 95°C; total time, 24 hr.

Figures 7 and 8 bring out several noteworthy points, viz., (1) bottle K, with a resistance to the solution at least as good as (or better than) bottles C, G, H, I, and J for time intervals as great as 24 hours at 95°C, is decidedly inferior to bottle C and no better than bottles G, H, I, and J in a prolonged test at 75°C; (2) the attack of the fairly concentrated alkali solution on bottle A shows a peculiar break (increase in rate of attack) when the alkali leached from the glass surface reaches a value of approximately 60 to 70 mg. per liter; this break is evident both in the 75° and 95° tests; (3) under both test conditions (75°C and 95°C), bottle A is superior to bottle E in resistance until approximately 160 mg. NaOH per liter is leached from the glass surface; after this point has been reached, bottle E becomes more resistant than bottle A; (4) in the tests conducted at 75°C, the rate of attack, in general, decreases with an increase in time of test for all bottles. Bottles A, D, and E, in particular, appear to reach values during the course of the test at which pronounced decreases in rate of attack occur.

Table V shows a 59-day test with *N*/50 NaOH solution conducted at room temperature on the various bottles. If the time necessary at 75°C to give an amount of attack equivalent to that obtained in 59 days at room temperature is determined, the period is less than one day for every bottle. If the time necessary at 95°C to obtain values equivalent to storage for 59 days at room temperature is found, less than one hour is required for bottle A, whereas approximately three hours are required for all other bottles. It is difficult to estimate from the test data available just how much time at room temperature would be required to get values as great as those obtained in 24 hours at 95°. For all the glasses shown, however, considerably more than one year probably would be required.

TABLE VII

COMPARISON OF ATTACK BY VOLUMETRIC AND GRAVIMETRIC METHODS

(24 hr., 95°C)*

Attacking medium	0.0085 *N* acid	0.0085 *N* acid	Water	Water
Bottle	(1)	(2)	(3)	(4)
A	18, 18	35	30, 31	130
B	4, 5	12	14, 15	73
C	15, 15	36	24F, 28F	114F
D	9, 9	27	19F, 18F	92F
E	9, 9	23	22, 22	92
F	18, 18	41	43, 43	162
G	8, 6	21	28F, 28F	140F
H	16, 16	36	50F, 50F	252F
I	29, 28	57	38F, 38F	194F
J	17, 17	37	47F, 46F	210F
K	10, 7	25	81F, 81F	422F

Column (1), NaOH; (2) solids as sulfates; (3) NaOH (4) solids as sulfates; all in mg. per liter.

* Symbol F following any numerical value indicates presence of flakes or spicules in solution.

None of the tests conducted with *N*/50 NaOH means a great deal in terms of the serviceability of a bottle for commercially packaging an alkaline solution of this concentration. The real criterion of performance in packaging such highly alkaline solutions should be the tendency to form flakes or visible precipitate rather than the amount of alkali leached from the glass surface.

(4) Significance of Accelerated Dilute Acid and Distilled Water Tests in Predicting Glass Bottle Resistance to Neutral Solution

An examination of Table VI brings out interesting information. The results indicate that the action of a buffer solution with a pH of 7.6 (practically neutral) is more nearly similar to that of a dilute acidic solution than to that of distilled water. As a matter of fact, in the 12- and 24-hour tests, results obtained with the buffer and the acid solutions are almost identical for every bottle, whereas those obtained with distilled water are substantially greater in every instance. It thus seems highly probable that as far as accelerated tests are concerned, dilute acid tests are a better criterion of the resistance of a glass bottle to a neutral solution than the distilled water tests.

(5) Relative Amounts of Corrosion by Distilled Water and Dilute Acid in Accelerated Tests

Table VII shows the amounts of total materials extracted from the glass surfaces of the various bottles by (*a*) dilute acid and (*b*) distilled water in a 24-hour test at 95°C. The results, under the test conditions used, indicate that the total amount of material extracted from the glass surface by distilled water is

considerably greater than that extracted by the dilute acid. This should have been expected because alkaline solutions (such as those in accelerated distilled water tests) are known to corrode glass surfaces considerably more than acidic solutions. The total material extracted by acids (when weighed as sulfates), in general, is between two and three times the amount of titratable alkali calculated as NaOH. The total material extracted in a water test, when weighed as sulfates, is between four and five times the amount of titratable alkali calculated as NaOH. This unquestionably is due to a difference in the mechanism of attack of acidic and alkaline solutions because it is highly probable that of the total amount of material extracted in the accelerated acid test at least 40 to 50% is alkali oxide, whereas of that extracted in the accelerated distilled water test, only 15 to 20% is alkali oxide.

IV. Conclusions

The general conclusions from the data thus far available in this work are as follows:

(1) A glass with good resistance to an acidic solution does not necessarily show good resistance to an alkaline solution in an accelerated test or vice versa.

(2) Accelerated tests conducted with dilute acidic solutions, either on glass grains or on the inside surfaces of glass bottles, appear to give results which ultimately may be interpreted in terms of the resistance of the glasses tested to the action of acidic solutions under commercial conditions, i.e., room temperature.

(3) Accelerated tests, conducted with distilled water as the initial leaching medium, do not measure the resistance of a glass to a neutral solution but rather to an alkaline solution, the concentration of which increases at different rates for different compositions of glasses tested.

(4) Because of obstacles already evident in attempts to interpret the resistance of glass to distilled water in tests conducted at temperatures of 95° and 121°C, in terms of the resistance of the same glasses to distilled water at a temperature of 50°C, it is improbable that results obtained in accelerated tests with distilled water may ever be interpreted in terms of the resistance of glasses to distilled water at room temperature.

(5) There is no absolute relation between the tendency of a bottle to form flakes when filled with distilled water and the amount of alkali leached from the glass surface by distilled water; this holds for all glass compositions.

(6) The value of an accelerated test either on glass grains or glass surfaces, with distilled water as the leaching medium, is questionable.

(7) Considerable difficulty probably will be encountered in attempting to relate accelerated tests conducted with $N/50$ sodium hydroxide solution to the commercial performance of the bottles filled with alkaline solutions of a similar concentration.

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DIELECTRIC LOSS OF GLASS AT HIGH FREQUENCIES*

BY H. THURNAUER AND A. E. BADGER†

ABSTRACT

Power factor measurements at frequencies of 100, 500, 1500, and 5000 kilocycles were made on a series of soda-lime-silica glasses and on another series of glasses, starting with a base glass of the composition of 17.4% Na_2O, 10.1% CaO, 72.5% SiO_2 (or 1.4 Na_2O to 0.9 CaO to 6.0 SiO_2), to which 0.030 gram-atom of various elements in the form of their oxides were added. In the first series, the power factor for all glasses measured decreased with increasing frequency and increased markedly with increase in Na_2O content. In the second series, the power factor decreased with increasing frequency as in the case of the first series. An increase in power factor was produced by additions of Zr, Na, and Al oxides, and a decrease was produced by additions of the oxides of Si, V, Zn, Mg, B, Ti, Co, Ca, Ce, Ni, Mn, Fe, Ba, Pb, Li, and K.

I. Introduction

A study of dielectric losses of glasses[1] has practical importance in high-frequency circuits and may have theoretical significance relative to the constitution of glass.

Only the power factors of the glasses have been measured in the present investigation. These values must be multiplied by the capacities of the glasses in order to obtain the dielectric losses. Because the capacities of the glasses were not determined, this study is restricted to dielectric losses as affected by changes in power factor.

* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 18, 1939 (Glass Division). Received June 26, 1939.

† Mr. Thurnauer is employed by the American Lava Corp., Chattanooga, Tenn.; Dr. Badger is a member of the staff of the Dept. of Ceramic Engineering, Engineering Experiment Station, Univ. of Illinois, Urbana, Ill.

[1] J. T. Littleton and G. W. Morey, "Consideration of Dielectric Losses of Glasses," in Electrical Properties of Glass, Chapter IV. John Wiley & Sons, New York, N. Y., 1933; *Ceram. Abs.*, **12** [12] 419 (1933).

Two different fields of glasses have been studied. In the first part, a series of soda-lime-silica glasses has been investigated in an attempt to correlate the power factors with their other known properties. The second part is concerned with glasses containing equivalent additions of various oxides to a soda-lime-silica glass.

Measurements were made at room temperatures of 25° to 30°C. The accuracy of the determinations is within 10% of the measurements.

II. Description of Apparatus

The measurements were made with a commercial instrument known as the Q-meter,* by means of which the power factors of insulating materials may be obtained at frequencies varying from 50 kilocycles to 50 megacycles.

The theory of the method of measurement employed in the Q-meter is illustrated schematically in Fig. 1.

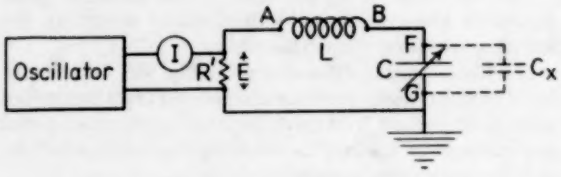

FIG. 1.—Schematic diagram of Q-meter.

The oscillator furnishes a current, measured by means of ammeter I, which flows through resistor R'. This resistance, R' (0.04 ohm), is small compared with the other resistances in the circuit and may be neglected. A known voltage, E, is then introduced into the series circuit, comprising variable condenser C and inductive reactor L connected across terminals A–B. Condenser C, contained in the instrument, has a negligible effective resistance. To determine the power factor of an insulating material, the sample is made into a condenser and the power factor of this condenser is determined.

A coil of suitable inductance is connected to coil terminals A–B of the Q-meter to resonate at the desired frequency. The oscillator frequency is set to the value desired, and the Q-circuit is resonated by means of Q-tuning condenser C, calling the condenser dial reading C_1. Test condenser C_x is connected to condenser terminals F–G of the Q-meter in parallel to tuning condenser C, and the Q-circuit is re-resonated with Q-tuning condenser C, calling the new setting C_2. The capacitance, C_p, of test condenser C_x is $C_p = C_1 - C_2$. The value of C_p thus obtained is the effective parallel capacitance of the test condenser.

The power factor is determined by observing the difference in circuit Q, with and without the test condenser connected into the circuit. The Q of test condenser Q_x is

$$Q_x = \frac{(C_1 - C_2)\, Q_1 \times Q_2}{C_1\,(Q_1 - Q_2)}.$$

The percentage power factor (for values less than about 10%) is as follows:

$$\text{Power factor} = \frac{100}{Q_x} = \frac{100 \times C_1\,(Q_1 - Q_2)}{(C_1 - C_2)\, Q_1 \times Q_2}.$$

Where C_1 = capacitance of Q-circuit alone.
Q_1 = Q of Q-circuit alone.
C_2 = capacitance of Q-circuit with test condenser connected to Q-circuit.
Q_2 = Q of the Q-circuit with test condenser connected to Q-circuit.
Q_x = Q of test condenser.

III. Preparation of Samples

The glass samples used in these tests were made from melts in platinum crucibles from which disks were cast, about $1^1/_2$ inches in diameter and $^1/_8$ inch thick. These disks, after annealing, were finely ground to form parallel faces. They were provided with conducting surfaces by applying a thin film of vaseline to the glass disk and pressing tin foil into close contact with the sample, excluding all air pockets and excess vaseline. Connections to the tin-foil surfaces were made by copper contacts tightly pressed against both surfaces. Care was taken to exclude moisture from the test samples, and before any readings were taken, the test pieces were left in a desiccator for forty-eight hours and longer until a constant reading was obtained.

IV. Results and Conclusions

Table I gives the compositions and power factors at various frequencies of glasses in the soda-lime-silica field. The chemical compositions were obtained by calculations from the glass batches. The numbers and positions of these glasses, superposed on an equilibrium

TABLE I

COMPOSITIONS AND POWER FACTORS OF GLASSES IN THE SODA–LIME–SILICA SYSTEM

Glass No.	Composition (%)			Power factor (%) at			
	Na_2O	CaO	SiO_2	100 kc.	500 kc.	1500 kc.	5000 kc.
2	34		66	9.10	5.42	4.45	3.44
4	10.5	28.5	61	0.38	0.37	0.27	0.23
6	19	10	71	1.15	1.05	0.91	0.90
7	14	10	76	1.10	0.98	0.84	0.80
8	26	3	71	1.43	1.25	0.85	0.82
9	26	7	67	2.32	2.03	1.57	1.46
11	36		64	19.30	6.70	1.96	1.83
12	32	4	64	5.00	2.57	2.58	2.13
13	28	8	64	2.27	1.82	1.37	1.22
14	24	12	64	1.25	1.13	1.15	0.84
15	20	16	64	0.78	0.71	0.51	0.52
16	30		70	5.28	3.85	2.78	2.38
17	26	4	70	3.13	2.33	1.67	1.49
18	22	8	70	1.43	1.31	1.00	0.93
19	18	12	70	0.95	0.98	0.76	0.70
20	14	16	70	0.67	0.72	0.49	0.50
21	26		74	3.85	3.03	2.44	2.00
22	22	4	74	2.00	1.75	1.39	1.19
23	18	8	74	1.18	1.14	0.92	0.91
24	14	12	74	0.83	0.82	0.81	0.61
25	10	16	74	0.67	0.66	0.61	0.56
26	22		78	2.50	1.87	1.60	1.32
27	18	4	78	1.41	1.39	1.11	0.93
28	14	8	78	1.05	0.92	0.70	0.65
29	10	12	78	0.67	0.66	0.60	0.54

* Manufactured by the Boonton Radio Corp., Boonton, N. J.

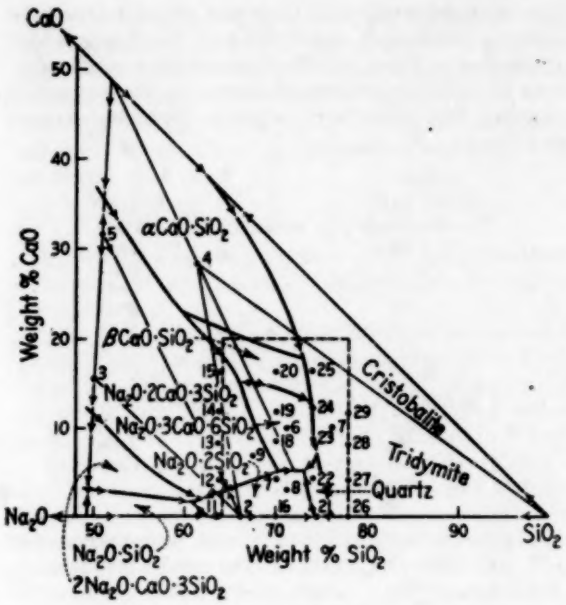

FIG. 2.—Numbers and positions of glasses in Na_2O–CaO–SiO_2 system superposed on Morey diagram.[2]

diagram published by Morey,[2] are given in Fig. 2. Most of the glasses lie within the important commercial field enclosed in dotted lines on Fig. 2.

Table I shows that the power factor decreases with increasing frequency and increases markedly with increase in Na_2O content. The latter effect is illustrated in Fig. 3 which shows lines of equal power factor at 100 kc. in relation to a portion of the ternary system taken from the publication of Morey.[2] There is no evident relation between the power factors of the glasses and the equilibrium diagram.

Parmelee and White[3] have determined specific resistances on the same series of glasses made of mixtures of soda, lime, and silica, as given in Table I, and have found that high-resistance glasses in this field of composition possess low power factors. The lack of correlation between either of these electrical properties and the equilibrium diagram confirm dissimilarities in relation to other physical properties.

Glass No. 4 (Table I and Fig. 2) had the lowest power factor of all glasses measured and therefore is useful for high frequency applications.

A second group of glasses[4] has been studied to find the change in power factor of a soda-lime-silica glass when various oxides are incorporated in this base glass. The base glass chosen had the chemical composition 17.4%

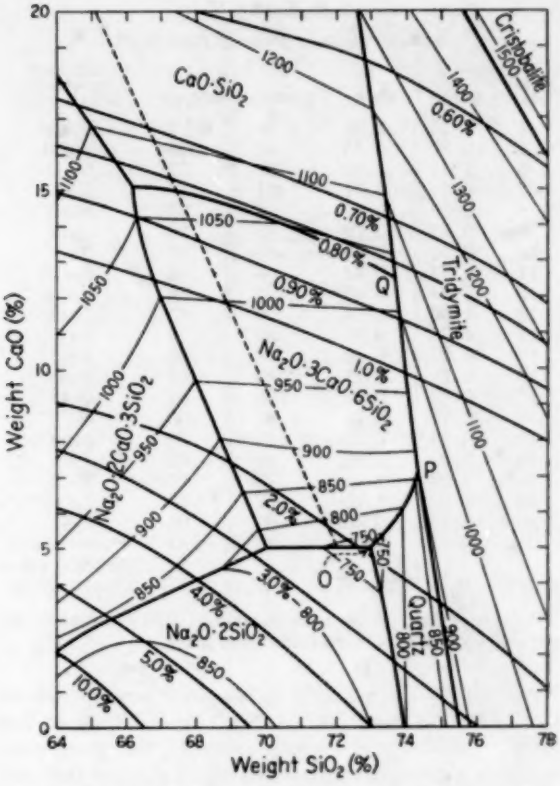

FIG. 3.—Lines of equal percentage power factor superposed on portion of Na_2O–CaO–SiO_2 system applicable to glass technology (Morey diagram[2]); weight per cent Na_2O obtained by difference; 100 kc. frequency.

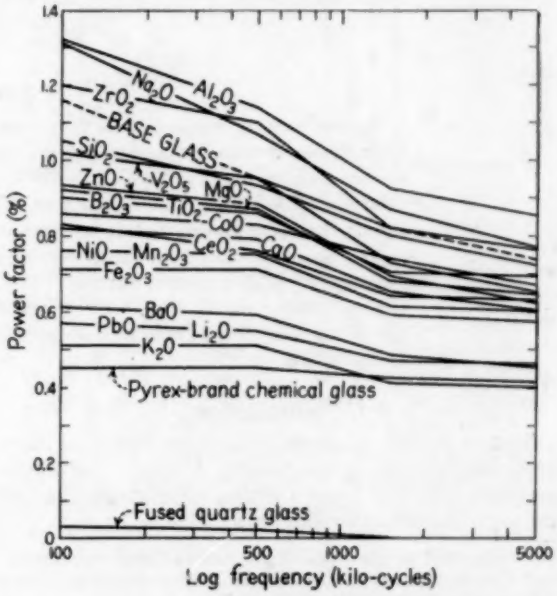

FIG. 4.—Percentage of power factors of soda-lime-silica glass with oxide additions of 0.030 gram-atom; measurements at frequencies of 100, 500, 1500, and 5000 kc.

[2] G. W. Morey, "Interpretation of Phase Equilibrium Diagrams," *Glass Ind.*, **12** [4] 69–80 (1931); *Ceram. Abs.*, **10** [6] 458 (1931).

[3] C. W. Parmelee and J. F. White, unpublished data, University of Illinois, 1939.

[4] A. E. Badger, C. W. Parmelee, and A. E. Williams, "Surface Tension of Various Molten Glasses," *Jour. Amer. Ceram. Soc.*, **20** [10] 325–29 (1937); this paper lists the chemical compositions of these glasses as computed from the glass batches.

TABLE II

PERCENTAGE OF POWER FACTORS*

Glass No.	100 kc.	500 kc.	1500 kc.	5000 kc.	Additional substance in base glass
1	1.16	0.95	0.82	0.74	None
5	0.57	0.55	.47	.46	Li_2O
6	1.31	1.07	.87	.77	Na_2O
7	0.51	0.51	.41	.40	K_2O
8	0.92	0.87	.68	.67	MgO
9	0.82	0.79	.65	.60	CaO
10	0.61	0.59	.48	.45	BaO
11	0.93	0.88	.69	.66	ZnO
12	0.90	0.86	.70	.69	B_2O_3
13	1.32	1.14	.92	.85	Al_2O_3
14	1.05	0.93	.80	.72	SiO_2
15	0.57	0.55	.48	.46	PbO
16	0.71	0.71	.59	.57	Fe_2O_3
17	0.86	0.83	.74	.65	CoO
18	0.76	0.75	.61	.60	NiO
19	0.76	0.75	.61	.60	Mn_2O_3
39	0.89	0.86	.69	.62	TiO_2
41	1.02	0.95	.73	.70	V_2O_5
42	1.20	1.10	.82	.76	ZrO_2
43	0.83	0.76	.64	.63	CeO_2
P	0.45	0.45	.42	.41	Pyrex-brand chemical glass
S	0.06	0.04	.02	.00	Quartz glass

* Glasses formed by incorporating 0.030 gram-atom of various oxides in a soda-lime-silica glass.

Na_2O, 10.1% CaO, 72.5% SiO_2 (which corresponds to the molecular amounts 1.4 Na_2O to 0.9 CaO to 6.0 SiO_2). Additions of various oxides to this glass were made on a gram-atomic basis in such a manner that the same number of cations were added to the base glass. For example, 0.030 mol. CaO was added to the base glass in one sample and 0.015 mol. Na_2O was added to another. These additions contributed equal numbers of calcium or sodium atoms in the respective glasses. The oxides incorporated in the base glass were as follows:

Mol.		Mol.	
0.015	Li_2O	0.030	MgO
"	Na_2O	"	CaO
"	K_2O	"	ZnO
		"	BaO
		"	CoO
		"	PbO
		"	NiO

Mol.		Mol.	
0.015	B_2O_3	0.030	SiO_2
"	Al_2O_3	"	TiO_2
"	Fe_2O_3	"	ZrO_2
"	Mn_2O_3	"	CeO_2
"	V_2O_5		

The power factors of these glasses were measured at 100, 500, 1500, and 5000 kc. The results are shown in Table II and Fig. 4, which exhibit a decrease in power factor with increasing frequency. The power factor was raised by additions of ZrO_2, Na_2O, and Al_2O_3 to the base glass, whereas a decrease was produced by the oxides of Si, V, Zn, B, Mg, Ti, Co, Ca, Ce, Ni, Mn, Fe, Ba, Pb, Li, and K.

For the purpose of comparison, the power factors of Pyrex-brand chemical glass and of fused quartz glass are adjoined to Table II and Fig. 4.

SURFACE TENSION MEASUREMENTS ON MOLTEN GLASS BY A MODIFIED DIPPING CYLINDER METHOD*

BY C. L. BABCOCK

ABSTRACT

Surface tension measurements have been made on a series of both calcite and dolomite lime glasses by using a modified dipping cylinder method. The measurements cover the temperature range from 1100° to 1400°C. and the viscosity range from logarithm viscosity = 1.65 to logarithm viscosity = 3.30 (45 to 2000 poises). Measurements on ordinary liquids of known surface tensions were made for check purposes.

The results obtained on the glasses agree well with published data obtained by the maximum bubble-pressure method. The temperature coefficient of surface tension is approximately −0.02 dyne per cm. per degree C. The surface tension of glass at a particular temperature may be represented as a linear function of composition on a mol. fraction basis.

I. Introduction

Surface tension measurements on molten glass have been obtained by using various dynamic and static methods. Morey[1] gives a rather complete account of the work on surface tension before 1938.

The most accurate work has been done by various workers, using modifications of the dynamic method known as the maximum bubble-pressure method and first developed by Jaeger.[2] The dipping cylinder method, a static modification of the anchor ring, has been used with little success, and various reasons have been proposed to show why the results obtained are lower than those determined by the Jaeger method.

* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 19, 1939 (Glass Division). Received April 28, 1939.

[1] G. W. Morey, The Properties of Glass. American Chemical Monograph Series. Reinhold Publishing Corp., New York, N. Y., 1938; pp. 197–211; *Ceram. Abs.*, **18** [2] 48 (1939).

[2] F. M. Jaeger, "Change in Molecular Free Surface Energy of Liquids from −80° to + 1650°C.," *Z. anorg. allgem. Chem.*, **101**, 1–214 (1917).

Results obtained with a modified dipping cylinder method on a systematic series of twelve calcite-lime and twelve dolomite-lime glasses agree well with results on similar glasses determined by Parmelee and Harman,[3] by Badger, Parmelee, and Williams,[4] and Keppeler,[5] all of whom used the maximum bubble-pressure method.

II. Description of Apparatus

Figure 1 is a functional sketch of the apparatus used. This drawing is not to scale, but the actual dimensions are given here.

The glass under investigation is placed in platinum-rhodium crucible *A*, 2 1/2 inches in diameter and 3/4 inch deep. The glass sample fills the crucible to a depth of 1/2 inch. Furnace *B* is wound with platinum-rhodium resistance wire on an Alundum core with a 3-inch bore.

The crucible of glass rests on refractory base *C*, which may be raised and lowered by means of a rack and pinion arrangement, indicated at *D*. Temperatures are measured with platinum-rhodium thermocouple *E*, placed at the same level as the top rim of the crucible, 1/4 inch above the glass surface. Investigation of the temperature gradient in the furnace shows that this temperature is less than 5°C. within the temperature of the glass under test. This difference is inconsequential because the temperature coefficient of surface tension is small, approximately −0.02 dyne per cm. per °C.

Dipping cylinder *F* is 1 inch in diameter and 3/4 inch high. The thickness of the cylinder is 0.005 inch. The cylinder is suspended on a platinum wire which passes through a small hole in the top of the furnace and thence to calibrated spring *G* on standard Jolly balance *H*. The calibrated spring is at a distance of three feet above the top of the furnace. Actual tests show that when the glass is at 1400°C. the calibration of the spring is the same as the calibration taken in the regular manner. Measurements show that the temperature of the spring was near 25°C. for runs in the temperature interval used, i.e., 1100° to 1400°C.

III. Method of Measurement

Preliminary measurements were made on methyl methacrylate dissolved in a solvent, tap water, distilled water, glycerol, and ethyl alcohol at room temperature (25°C.) to test the proposed method, using liquids of known surface tensions, and to study its action under conditions where observations could easily be made.

The set-up for this work was the same as is shown in Fig. 1, except that the furnace was removed. The Jolly balance has a small metal cylinder, carrying three graduations, which is attached to the calibrated spring by means of a wire. This metal cylinder moves up and down inside a glass cylinder, open at both ends, which carries a single graduation and which is fixed to the frame of the balance. This assembly is shown at *I* in Fig. 1. The adjustable barrel of the Jolly balance has a millimeter scale with a vernier, shown at *J*.

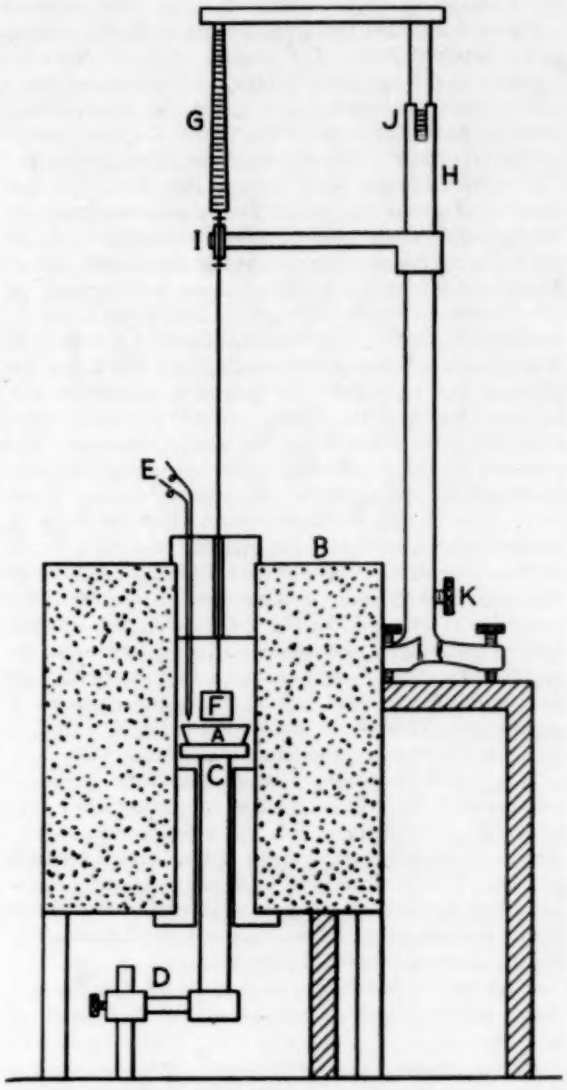

FIG. 1.—Dipping cylinder apparatus.

Figure 2 shows details of the dipping cylinder and the method of measurement. The cylinder is open both at top and bottom. The supporting wire is bent into the shape of a hook and is attached to the ring on the cylinder which is at the junction of the two cross wires on the top of the cylinder. The diagrams, *A* to *G*, show section *A–B* of the cylinder in the different stages of the measurement. Diagrams *H*, *I*, and *J* show sections of the rim of the cylinder and the liquid level during the measurements. The liquid level inside of

[3] C. W. Parmelee and C. G. Harman, "Effect of Alumina on Surface Tension of Molten Glass," *Jour. Amer. Ceram. Soc.*, **20** [7] 224–30 (1937).

[4] A. E. Badger, C. W. Parmelee, and A. E. Williams, "Surface Tension of Various Molten Glasses," *ibid.*, **20** [10] 325–29 (1937).

[5] G. Keppeler, "Surface Tension of Glass," *Jour. Soc. Glass Tech.*, **21** [83] 53–60 (1937); *Ceram. Abs.*, **17** [8] 275 (1938).

the cylinder is higher than it is on the outside.

Figure 2-*A* shows the arrangement at the beginning of the determination. The reading on scale *J*, corresponding to this coincident position of the fixed and movable indices, is recorded and called the zero reading of extension. The level of the liquid is raised slowly until it touches the bottom rim of the dipping cylinder. The surface tension pulls the cylinder down into the liquid as shown in Fig. 2-*B*. The cylinder is prevented from going down to the bottom of the crucible by stops placed on the metal cylinder carrying the movable index. The movable barrel of the Jolly balance is then raised by the adjustment screw at *K* until the indices are again coincident (Fig. 2-*C*). The reading of scale *J* is recorded. The difference between this reading and that taken for position 2-*A* represents the extension caused by the surface tension of the liquid. It will be shown later that this gives a low value for surface tension. The shape of the liquid adhering to the bottom of the platinum cylinder indicates that the angle of contact is not zero. Use of this method requires that the angle of contact of the liquid with the cylinder be zero.

This procedure, viz., alternate lowering the level of the liquid and obtaining a balance, is followed until the condition represented in Fig. 2-*G* is obtained wherein further lowering of the liquid no longer causes an increase in extension. At a certain height above the surface of the liquid, the pull on the cylinder reaches a maximum. This height was of the order of $^1/_8$ to $^3/_{16}$ inch for the liquids (other than glass) investigated.

Figure 2-*H* shows the general shape of the liquid in contact with the cylinder for low values of surface tension. Figure 2-*I* shows this shape for correct values, and 2-*J*, the momentary shape if the level is lowered further. Further lowering after the maximum value of surface tension had been obtained caused the film to break immediately. From observations and from Fig. 2-*I* the angle of contact is close to zero.

After this work had been in progress for some time, it was found that Harkins and Jordan[6] had used a method for determining surface and interfacial tensions from the maximum pull of a ring. The method used here is similar in principle to theirs in that the maximum pull was determined; the actual set-ups, however, are quite different.

The equation for surface tension which is used for this method and technique is the well-known relation,

$$\text{Surface tension (dynes/cm.)} = \frac{kgE}{2L}.$$

Where k = constant of spring = 1.04 grams/cm. extension.
g = acceleration of gravity (980.24 cm./sec.^{2}).
E = extension of spring (cm.).
L = circumference of cylinder (cm.).

Modifications of the dipping cylinder method have been used by R. G. Hunter[7] and by Harrison and Moore,[8] in which the pull was determined when the bottom of the dipping cylinder was coincident with the liquid level.

IV. Results on Various Liquids

Table I gives results on various liquids of known surface tensions. Measurements were taken at a temperature of 25°C. in air. The known values are taken from published tables at temperatures close to 25°C.; the measured values of surface tension given are averages of five individual determinations.

TABLE I

RESULTS ON LIQUIDS OF KNOWN SURFACE TENSIONS

Liquid	*L* (cm.)	Kg./2*L*	*E* (cm.)	Surface tension (dynes/cm.)	Known value (°C.)
Tap water	12.00	42.1	1.52	64.0	
Distilled water	12.00	42.1	1.67	70.3	72 (25)
	8.14	62.7	1.14	71.5	72 (25)
Glycerol	12.00	42.1	1.49	62.7	63 (18)
Ethyl alcohol	12.00	42.1	0.55	23.1	22 (30)
Methyl methacrylate	12.00	42.1	0.80	33.7	
	8.14	62.7	0.53	33.2	

All of the liquids except ethyl alcohol behaved in the manner described in section III. Different samples of ethyl alcohol gave the same extension and therefore the same value of surface tension for all positions shown in Fig. 2. The value of the surface tension of tap water (Fig. 2) was 57.1 dynes per cm. for position *C;* 60.5 for position *E;* and 64.0 for position *G*. The latter was the maximum value for the extension and therefore the correct value of the surface tension.

V. Composition of Glasses

The measurements reported here were made on glasses selected from two large series of glasses. Meas-

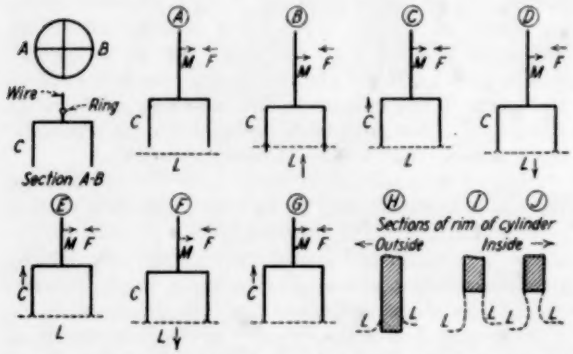

FIG. 2.—Various stages in surface tension measurement; *C*, cylinder; *F*, fixed index; *L*, liquid level; *M*, movable index.

[6] W. D. Harkins and H. F. Jordan, "Determination of Surface and Interfacial Tension from Maximum Pull on Ring," *Jour. Amer. Chem. Soc.*, **52** [5] 1751–72 (1930).

[7] C. W. Parmelee and K. C. Lyon, "Maximum Bubble Pressure (Jaeger) Method for Measuring of Surface Tension of Molten Glass," *Jour. Soc. Glass Tech.*, **21** [83] 44–52 (1937); *Ceram. Abs.*, **17** [8] 275 (1938).

[8] W. N. Harrison and D. G. Moore, "Surface Tension of Vitreous Enamel Frits at and near Firing Temperatures," *Jour. Research Nat. Bur. Stand.*, **21** [3] 337–46 (1938); R. P. 1133; *Ceram. Abs.*, **18** [1] 13 (1939).

TABLE II

CHEMICAL ANALYSES AND MOL. FRACTION COMPOSITION OF GLASSES

Glass No.		C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10	C-11	C-12
Percentage by weight composition	SiO_2	74.4	70.7	66.4	73.7	69.5	72.7	71.0	66.8	74.1	69.4	72.9	68.9
	Al_2O_3	0.2	0.2	0.1	0.2	0.2	0.3	4.2	4.2	4.1	4.2	4.1	4.2
	CaO	7.9	11.7	15.8	11.8	15.7	15.8	7.8	11.8	7.7	12.0	11.7	15.5
	MgO	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.3
	Na_2O	17.0	17.0	17.2	14.2	14.1	10.8	17.0	17.0	13.8	14.0	11.0	10.9
	SO_3	0.3	0.3	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4
Mol. fraction composition	SiO_2	0.745	0.702	0.661	0.731	0.690	0.719	0.718	0.674	0.747	0.704	0.734	0.690
	Al_2O_3	0.001	0.001	0.001	0.001	0.001	0.001	0.025	0.025	0.025	0.025	0.025	0.025
	CaO, MgO	0.088	0.131	0.174	0.131	0.174	0.174	0.089	0.133	0.089	0.133	0.133	0.177
	Na_2O	0.166	0.165	0.164	0.136	0.135	0.106	0.168	0.168	0.139	0.138	0.108	0.108

Glass No.		D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-10	D-11	D-12
Percentage by weight composition	SiO_2	73.4	67.4	75.1	69.3	77.6	71.0	69.8	63.6	70.8	65.3	73.9	67.5
	Al_2O_3	0.1	0.3	0.3	0.4	0.3	0.3	4.3	4.3	4.3	4.4	4.1	4.5
	CaO	6.1	9.5	5.8	9.4	5.9	9.8	5.8	9.6	6.0	9.6	5.9	9.6
	MgO	4.2	6.5	4.1	6.4	4.0	6.7	4.0	6.5	4.1	6.4	4.1	6.7
	Na_2O	15.8	15.8	13.9	13.9	12.1	12.2	15.6	15.6	14.1	14.0	11.8	11.6
	SO_3	0.2	0.4	0.4	0.4	0.1	0.1	0.4	0.4	0.4	0.4	0.1	0.1
Mol. fraction composition	SiO_2	0.723	0.654	0.742	0.673	0.760	0.692	0.694	0.625	0.714	0.644	0.734	0.664
	Al_2O_3	0.001	0.001	0.001	0.001	0.001	0.001	0.025	0.024	0.025	0.024	0.025	0.024
	CaO, MgO	0.123	0.194	0.123	0.194	0.123	0.194	0.125	0.197	0.125	0.197	0.125	0.197
	Na_2O	0.153	0.151	0.134	0.132	0.115	0.113	0.156	0.153	0.136	0.134	0.117	0.115

urements on various physical and chemical properties have been made on these systematically arranged series of glasses.

The glasses were melted in platinum-rhodium melting crucibles, using analyzed raw materials to give 2000 grams of glass sample. Table II gives the actual chemical analyses of the glasses together with the theoretical composition expressed on a mol. fraction basis. The actual chemical analyses are near enough to the theoretical composition to allow doing this. The mol. fraction compositions are given with the lime and soda contents to the nearest percentage; the alumina contents, 0.2 and 4.2%; and the remainder, silica.

VI. Results on Molten Glass

Surface tension measurements were made on the twenty-four glasses following the method described in section III. In making measurements on glass, it was necessary to dip the cylinder into the glass a few times until a constant weight of glass was held on the cylinder. In other words, readings were not taken until the so-called zero extension reading had become constant. The weight of glass adhering to the cylinder increased as the viscosity of the glass increased.

The measurements cover the temperature range from 1100° to 1400°C, and the approximate viscosity range is from 45 to 2000 poises. Measurements can only be made with difficulty and with low precision on glasses having viscosities higher than roughly 2000 poises. Glasses having viscosities in this range must be measured carefully because it is possible to determine the maximum pull and then to obtain a lower extension by increasing the height of the cylinder above the glass surface. Such data have been obtained on some of the glasses reported, the high viscosity of the glass allowing this temporary condition to persist for a short time.

A pull of less than the maximum after the maximum had been reached was not observed on any of the liquids or on the glasses of low viscosity. In their work on ordinary liquids, Harkins and Jordan[8] state that they were able to make measurements beyond the maximum pull only with great difficulty and that the precision of such measurements was quite low.

The height of the rim of the cylinder above the glass surface corresponding to the maximum pull, and therefore the correct surface tension value, was of the order of $^3/_{16}$ to $^1/_4$ inch. The value of the constant, $kg./2L$, is 61.95, the average value for the temperature interval covered. The circumference of the cylinder is 8.137 cm. at 25°C., and 8.228 cm. at the average temperature, i.e., 1250°C. The experimental values given in Table III are averages of five individual readings. The average of the maximum differences between the individual measurements and the values given is 3 dynes per cm. The approximate error of individual measurements for the system of twenty-four glasses is therefore about $\pm 1\%$.

The temperature coefficient of surface tension for the glasses measured is -0.02 dyne per cm. per °C. Smooth-curve values for the glasses were taken from straight-line plots best representing the experimental data and conforming to the given temperature coefficient of surface tension. The average difference between the experimental data and the smooth-curve data for all glasses is 0.5 dyne per cm. The maximum difference between any single value and the smooth-curve value is 2 dynes per cm.

VII. Discussion of Results

Figures 3 and 4 show the smooth-curve values at 1400°C. on plots of the mol. fraction of soda against the mol. fraction of lime for the two alumina contents. The lines of equal surface tension on these plots are

TABLE III

EXPERIMENTAL DATA FOR GLASS SURFACE TENSION

(dynes per cm.)

Calcite

C-1		C-2		C-3		C-4		C-5		C-6	
°C.	S.T.*	°C.	S.T.*	°C.	S.T.*	°C.	S.T.*	°C.	S.T.*	°C.	S.T.*
1400	303	1395	312	1400	317	1400	316	1397	322	1400	325
1245	307	1302	315	1288	319	1325	315	1318	325	1306	326
1230	308	1216	316	1236	323	1238	318	1242	326	1248	328
1100	309	1140	317	1185	324	1168	317	1195	327	1232	330
				1120	321						

C-7		C-8		C-9		C-10		C-11		C-12	
1388	313	1393	323	1395	320	1392	327	1400	330	1402	332
1334	314	1292	325	1360	321	1319	327	1330	330	1370	332
1327	314	1244	325	1323	323	1248	329	1306	331	1330	333
1271	316	1177	327	1247	324	1217	330	1250	333	1291	333
1219	319									1234	336
										1231	336

Dolomite

D-1		D-2		D-3		D-4		D-5		D-6	
1387	309	1408	321	1397	316	1363	329	1406	322	1380	332
1317	310	1336	323	1339	317	1268	330	1370	323	1317	332
1304	311	1248	323	1288	318	1216	331	1270	324	1255	333
1275	311	1152	326	1195	320	1200	331	1255	327	1229	336
1208	313					1150	332			1185	338

D-7		D-8		D-9		D-10		D-11		D-12	
1393	319	1390	328	1395	325	1380	333	1400	328	1382	340
1334	321	1310	330	1329	326	1300	336	1380	328	1312	339
1277	322	1210	334	1260	328	1210	338	1348	329	1231	342
1213	324	1148	335	1215	328	1150	339	1294	330	1170	343

* S.T. = surface tension.

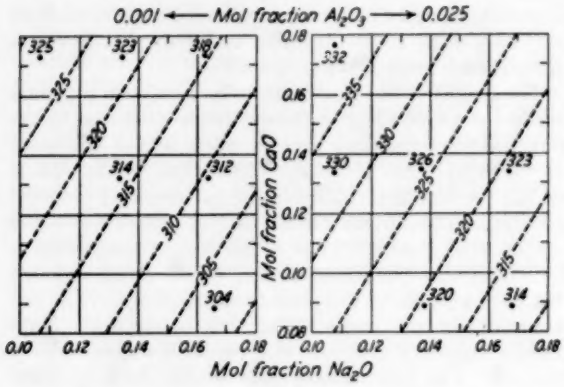

FIG. 3.—Surface tension of CaO glasses at 1400°C. in dynes per cm.

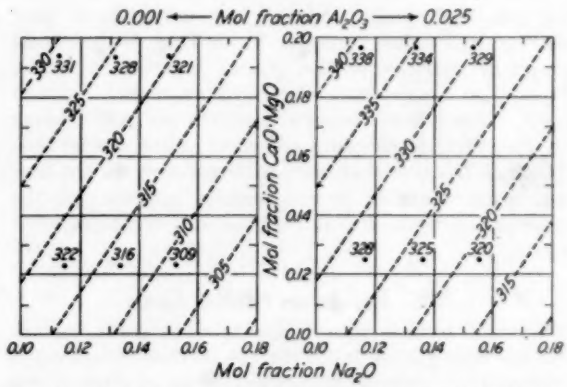

FIG. 4.—Surface tension of CaO·MgO glasses at 1400°C. in dynes per cm.

calculated from a series of constants which allows one to represent the data as linear functions of the mol. fraction composition. This calculated system of lines was adjusted to fit the experimental data closely.

Table IV gives the effect of the substitution of one oxide for another upon the surface tension in dynes per centimeter at 1400°C. Surface tension values are found at any other temperature by taking into account the temperature coefficient of surface tension; the surface tension increases 2 dynes per cm. for each lowering of the temperature by 100°C. The values given are dynes per cm. increase in surface tension produced by a substitution of 0.1 mol. fraction of one oxide for another. Given the mol. fraction composition of a soda

TABLE IV

SURFACE TENSION INCREASE

(At 1400°C. in dynes per cm. by substitution of 0.1 mol. fraction of one oxide for another)

Al_2O_3	for Na_2O	= 64.3
Al_2O_3	for SiO_2	= 42.0
MgO	for Na_2O	= 38.7
CaO·MgO	for Na_2O	= 37.4
CaO	for Na_2O	= 36.1
Al_2O_3	for CaO	= 28.2
Al_2O_3	for CaO·MgO	= 26.9
Al_2O_3	for MgO	= 25.6
SiO_2	for Na_2O	= 22.3
MgO	for SiO_2	= 16.4
CaO·MgO	for SiO_2	= 15.1
CaO	for SiO_2	= 13.8
MgO	for CaO	= 2.6
MgO	for CaO·MgO	= 1.3
CaO·MgO	for CaO	= 1.3

TABLE V

GLASS COMPOSITIONS WITH EXPERIMENTAL DATA

Glass No.	Mol. fraction composition SiO_2	Al_2O_3	CaO	MgO	Na_2O	Dynes/cm.	Calculated surface tension	Difference (%)
			Data of Badger, Parmelee, and Williams[4] (1350°C.)					
1	0.720		0.109		0.170	302	306	1.3
6	.703		.106		.191	298	301	1.0
8	.686		.102	0.052	.160	314	316	0.6
9	.685		.154		.161	310	314	1.3
13	.704	0.026	.105		.165	313	317	1.3
14	.736		.103		.161	303	308	1.7
			Data of Parmelee and Harman[3] (1350°C.)					
S-0	0.720		0.083	0.045	0.153	305	313	2.6
S-2	.708	0.012	.081	.045	.154	318	317	0.3
S-4	.704	.022	.081	.044	.150	325	322	0.9
S-8	.687	.045	.078	.043	.147	337	333	1.2
			Data of Keppeler[5] (1400°C.)					
I	0.761	0.008	0.096		0.135	321	315	1.9

lime-alumina-silica glass and its surface tension at a particular temperature, the surface tension of a glass of known composition may be calculated at any temperature in the range covered.

It is possible to represent the data on the calcite-lime glasses as a linear function of percentage by weight composition, using constants for 1% substitutions of one oxide for another. The same thing may be done with the data in the dolomite-lime glasses, but substitutions for common oxides are different in the two series of glasses. For example, the 1% substitution of SiO_2 for soda is approximately two and one-half times as large for the dolomite-lime glasses as for the calcite-lime glasses. It appears that all the data may be included only in a system of representation which expresses the compositions in terms of mol. fractions.

The average difference between the experimental data and the values calculated using the system of constants is 1.8 dynes per cm. The maximum difference between any single value and the calculated value is 6 dynes per cm. Glass C-12 is 6 dynes per cm. from the calculated value at 1400°C.; all other individual differences are 3 dynes per cm. or less.

VIII. Comparison with Published Data

Parmelee and Harman,[3] Badger, Parmelee, and Williams,[4] and Keppeler,[5] have made surface tension measurements using the maximum bubble-pressure method. Table V shows the compositions of these glasses and their experimental data. The surface tensions for these glasses have been calculated, using base glasses taken from Figs. 3 and 4, and the constants are given in Table IV. The percentage differences between their measured values and those calculated for the particular temperature are given.

Results obtained by using a dipping cylinder method are shown to agree well with those obtained by the maximum bubble-pressure method. The surface tension of molten glass in the temperature interval 1100° to 1400°C. may be represented as a linear function of glass oxides expressed on a mol. fraction basis.

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DETERMINATION OF QUARTZ (FREE SILICA) IN REFRACTORY CLAYS*

By L. J. Trostel and D. J. Wynne

Abstract

A rapid procedure is described for determining quartz in refractory clays by fusion in potassium bisulfate and subsequently by dissolving precipitated silica with a hot caustic solution. Data are included on the quartz content of several clays.

I. Introduction

It is frequently important, in guiding certain manufacturing operations, to know the free silica, or quartz, content of clays and other ceramic bodies, and an increasing interest has been exhibited in accurate methods for determinations of this type.

The refractory clays, according to McDowell,[1] contain two essential constituents, kaolinite and hydromica. The Pennsylvania nodule and Missouri diaspore clays, however, consist mainly of diaspore. Quartz is the major accessory constituent of fire clay, and the chief minor accessory constituents include various iron compounds and rutile. Other minerals commonly present in small amounts are tourmaline (a complex silicate of boron and aluminum), epidote (a hydrated lime-iron aluminum silicate), zircon ($ZrO_2 \cdot SiO_2$), and titanite ($CaO \cdot TiO_2 \cdot SiO_2$). Some clays have been reported to contain varying amounts of calcite ($CaCO_3$), gypsum ($CaSO_4 \cdot 2H_2O$), glauconite (hydrated silicate of potash and iron), and garnet. Contrary to general belief, feldspar is not an important constituent of most refractory clays, and it is not often identified under the microscope.

A method suitable for the determination of quartz accordingly must employ a solvent capable of dissolving quantitatively a wide variety of minerals but which would leave the quartz unattacked.

Petrographic methods for this purpose, such as those of Ross and Sehl,[2] employ the Rosiwal[3] counting technique and are capable of only fair accuracy. Chemical methods, such as that of Knopf,[4] which depend on the selective dissolving action of hydrofluosilicic acid on the silicates leaving the quartz comparatively unaffected, as well as the method of Line and Aradine,[5] which substitutes fluoboric for the hydrofluosilicic acid, offer an improvement in accuracy over petrographic methods. Both of the acids employed, however, are slow in effecting solution of the silicate minerals. A minimum of about 24 hours with the hydrofluosilicic acid and 48 hours with fluoboric acid, for example, is required to break down the silicates. The time required for some silicates may be 10 days or more, and some laboratories have reported that several weeks may be required to break down certain clays or silicates. The slight solvent action of both acids on quartz, furthermore, becomes important in view of the long period required for solution of the silicates. Hydrofluosilicic acid, for instance, at room temperature dissolves the quartz at the average rate of 0.70% and fluoboric acid at 50°C at the rate of 0.34% per day. Kaplan and Fales[6] have shown that by the application of a form of the compound-interest law a computation may be made of the dissolved quartz using these solution rates as correction factors. Accurate temperature control of the acids must be maintained during the extended solution period to insure correction factors of constant value. A feature of the method of Line and Aradine,[5] which would be considered a disadvantage in some industrial laboratories, is the necessity for the special preparation of the fluoboric acid.

The so-called "rational analysis,"[7] a chemical method used by early ceramic investigators but used only infrequently now, was employed to determine the "free silica" and "clay substance" that make up ordinary clays. This method involved digestion for 15 to 18 hours in hot concentrated sulfuric acid to dissolve the "clay substance," followed by treatment with boiling sodium carbonate, leaving the accessory constituents as a residue. This treatment of the residue was not always sufficient to separate the quartz from the other accessory constituents, and the method has fallen into disuse even for accurate determinations of the "clay substance."

(1) Modified Method for Quartz Determination

A modified chemical method is described in this paper, in which the sample is strongly fluxed with potassium pyrosulfate in a vitreous silica crucible. This familiar procedure is more efficacious than boiling in concentrated sulfuric acid to dissolve a wide range of aluminum silicate minerals and the highly aluminous or diasporitic clays. The silica, combined with the clay minerals, is liberated as silicic acid and is subsequently dissolved in a hot sodium hydroxide solution as contrasted with hot sodium carbonate. The quartz remains as a residue. A determination may be completed in a comparatively short length of time, i.e., 8 hours or

*Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 19, 1939 (Refractories Division). Received May 13, 1939.

[1] J. S. McDowell, "Mineralogy of Clay, I," *Jour. Amer. Ceram. Soc.*, **9** [1] 55–60 (1926).

[2] H. L. Ross and F. W. Sehl, "Determining Free Silica, Modified Petrographic Immersion Method," *Ind. Eng. Chem., Anal. Ed.*, **7** [1] 30–32 (1935); *Ceram. Abs.*, **14** [10] 260 (1935).

[3] Albert Johannsen, Manual of Petrographic Methods, pp. 291–92. McGraw-Hill Book Co., 1918.

[4] A. Knopf, *U. S. Public Health Rept.*, **48**, 183–90 (1933).

[5] W. R. Line and P. W. Aradine, "Determination of Quartz in Presence of Silicates," *Ind. Eng. Chem., Anal. Ed.*, **9** [2] 60–63 (1937); *Ceram. Abs.*, **16** [5] 160 (1937).

[6] E. Kaplan and W. T. Fales, "Chemical Determination of Quartz (Free Silica) in Dusts," *Ind. Eng. Chem., Anal. Ed.*, **10** [7] 388 (1938); *Ceram. Abs.*, **17** [10] 342 (1938).

[7] J. S. McDowell "Rational Analysis of Clay, II," *Jour. Amer. Ceram. Soc.*, **9** [1] 61–65 (1926).

slightly less, and no special apparatus or reagents are required. The prescribed temperatures during fluxing and treatment with sodium hydroxide, however, must be closely followed.

II. Procedure for Determination of Quartz

The procedure recommended for analysis of refractory clays is as follows: Weigh a 0.5-gram sample of the dried material, ground to pass 150-mesh, in a vitreous silica crucible. Fuse thoroughly with 10 to 15 grams of potassium pyrosulfate. Observe the usual precautions of a pyrosulfate fusion, viz., start the temperature low to prevent loss of SO_3 and finally finish up at a bright red heat not to exceed 1000°C. Heating should not be continued to the point where salts start freezing on top of the melt and sides of the crucible because of the difficulty of subsequent solution of the fusion.*

Dissolve the cooled fusion in 150 to 200 cc. of hot water in a 400-cc. beaker. To the warm solution add cautiously about 12 grams of sodium-hydroxide pellets, one or two at a time, to dissolve the precipitated silica. Digest on a hot plate for $^1/_2$ hour, maintaining the temperature at 85° to 90°C, then filter off the quartz quickly, using a paper of close texture. Thoroughly scrub and wash the beaker to insure complete transfer of the quartz. Wash 10 times with hot water and then 5 to 10 times with hot 1 to 1 hydrochloric acid to dissolve the iron and other compounds from the quartz not entirely removed by filtering; wash again 5 times with hot water. Ignite paper and residue and weigh in a tared platinum crucible. The residue contains the free quartz present in the sample.

NOTE: The quartz is contaminated occasionally with small amounts of compounds not removed by this treatment. This may be due either to incomplete solution of the original sample in the pyrosulfate fusion or to incomplete solution of the liberated silicic acid in the hydroxide. It is recommended that the separated quartz not only be examined with the microscope but also treated with hydrofluoric acid to determine the purity.

To the residue, add 2 drops of 1 to 1 sulfuric acid and 10 cc. of 48% hydrofluoric acid; evaporate to dryness, ignite, and weigh. Inspect the weight of this final residue; if it exceeds 0.001 gram, discard the determination and repeat.

III. Solubility of Clay Constituents in Reagents

Quartz is slightly attacked by potassium pyrosulfate under certain conditions mentioned by Sosman[8] in recounting the work of Friedel.[9] At 600°C, e.g., potassium pyrosulfate, which contains a little potassium fluoride, or the sulfate alone at 1200°C produced etch figures on quartz. In the type of fusion employed in the method described in this paper, no fluorides are present and the maximum recommended temperature is 1000°C; solution of the quartz therefore is highly improbable. In studies of the solubility of the various forms of silica, Searle[10] points out that Schwartz observed the amorphous varieties to be generally more soluble than the crystalline forms. The insolubility of vitreous or amorphous silica in potassium pyrosulfate at 1000°C has been known for many years, as represented in the common practice of employing crucibles of this type of silica to effect solution of refractory minerals. This is further evidence of the improbability of solution of crystalline quartz in potassium pyrosulfate at the temperature indicated.

Mellor[11] lists the work of various investigators on studies of the solubility of quartz in various caustic solutions. The conclusion may be drawn that quartz is slightly attacked, but definite conclusions pertaining to the rate of reaction are difficult because of the lack of pertinent data on the concentration and temperature of the solutions, the time the quartz is left in the solution, and the size and purity of the quartz grains tested.

Solution of quartz in hot caustic solutions, as explained by Hillebrand and Lundell[12] in citing the work of Lunge and Millberg, is likely only when the material has been reduced to an "utterly impalpable degree of fineness," which is practically never reached in the preparation of samples for mineral analysis. These authors say that for this reason, there need be no hesitation in employing a dilute solution of sodium hydroxide when the silica, separated by acid from one of several constituents of a rock, is to be estimated. There is some question of course as to the exact meaning of an "utterly impalpable degree of fineness."

Some of the quartz in clays is in the form of grains large enough to be seen with the naked eye. Galpin[13] has measured grains as large as 0.090 mm. in Pennsylvania flint clay, and McCaughey[14] observed grains as large as 0.05 mm. in certain coal-formation clays of Ohio.

All of the clay samples tested in the investigation described in this paper were ground to pass a 150-mesh Tyler sieve with openings of 0.105 mm. This would mean some reduction in size of the largest quartz grains

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* NOTE: A Méker or Bunsen burner or an electric muffle furnace in which the temperature may be maintained within the limits given is satisfactory for this purpose; a blast burner is to be avoided.

[8] R. B. Sosman, Properties of Silica, p. 512. The Chemical Catalog Co., Inc., New York, 1927; *Ceram. Abs.*, **7** [7] 505 (1928).

[9] G. Friedel, "Figures de Corrosion du Quartz à Haute Température," *Bull. soc. franç. minéral.*, **25,** 112–13 (1902).

[10] A. B. Searle, Refractory Materials, pp. 134–35. Charles Griffin & Co., Ltd., 1924.

[11] J. W. Mellor, A Comprehensive Treatise on Inorganic and Theoretical Chemistry, Vol. VI, Part II (Si, Silicates). Longmans, Green & Co., 1925; *Ceram. Abs.*, **5** [3] 105 (1926).

[12] D. F. Hillebrand and G. E. F. Lundell, Applied Inorganic Analysis, 929 pp. John Wiley & Sons, Inc., New York, 1929; p. 715; *Ceram. Abs.*, **9** [1] 68 (1930).

[13] S. L. Galpin, "Studies of Flint Clays and Their Associates," *Trans. Amer. Ceram. Soc.*, **14,** 301–46 (1912).

[14] Wilber Stout, R. T. Stull, W. J. McCaughey, and D. J. Demorest, "Coal Formation Clays of Ohio," *Geol. Surv. of Ohio* (in coöperation with U. S. Bureau of Mines), *4th Series, Bull.*, No. 26, 588 pp. (1923); p. 52; *Ceram. Abs.*, **3** [7] 231 (1924).

but not of those observed by McCaughey. A Bureau of Standards sample of glass sand, included by the authors in this investigation, was tested as received. In this form, approximately 90% passed a Tyler 300-mesh sieve with openings of 0.046 mm. Even 300-mesh grinding apparently is not sufficient to cause excessive solution of quartz as shown by the data for this material in Table I.

The modified chemical method described here substitutes sodium hydroxide for the sodium carbonate solution used in the "rational-analysis" method. It has been observed in this investigation that the silicic acid liberated from clay goes into solution almost at once with the hot sodium-hydroxide solution. Carbonate solutions, however, in the ½-hour digestion period used, were found to give high quartz values, which examination with the microscope indicated were due to contamination with undissolved silicic acid. When silicic acid, freshly precipitated from sodium silicate with hydrochloric acid, was treated with sodium hydroxide, immediate solution again took place. If it was treated, however, with a sodium carbonate solution of 5%, solution was not complete even after a ½-hour digestion. The high quartz values obtained with the carbonate solution appear to be due to its incomplete dissolving action in the digestion period used. Treadwell and Hall[15] point out that the solubility of silicic acid in carbonate or hydroxide solutions depends on the degree of hydration of the silica. Carbonate solutions become less effective as the degree of dehydration is more complete, until finally the strongly ignited anhydrite is dissolved only after repeated boiling for a long time. Ignited anhydrite, however, is readily dissolved by sodium hydroxide. Silicic acid, separated from clay with potassium pyrosulfate, is probably considerably dehydrated, and a hot sodium hydroxide solution appears to be the best solvent to use.

The temperature of 85° to 90°C suggested for the digestion period with sodium hydroxide is important. If the temperature is as low as 75°C, incomplete solution of the silicic acid results. If, however, the caustic solution is boiled, partial solution of the quartz results.

Feldspar, which occurs only infrequently (if at all) in refractory clays, is not dissolved by the pyrosulfate fusion as judged from tests made on samples of albite and oligoclase. Zircon ($ZrO_2 \cdot SiO_2$), traces of which are present in refractory clays, is likewise insoluble in potassium pyrosulfate.

IV. Data on Quartz Content of Clays

Table I gives the total silica and quartz content of a pure sand, eight clays of varying quartz content, and a synthetic mixture of clay and quartz. These data represent determinations in which the weight of the final residue after treatment with HF was nil or less than 0.001 gram. The material separated in each case was identified with the microscope as quartz.

The series in Table I includes nearly pure, quartz clay minerals, ranging from the kaolinite type ($Al_2O_3 \cdot \cdot 2SiO_2 \cdot 2H_2O$) to montmorillonite ($(MgCa)O \cdot Al_2O_3 \cdot \cdot 5SiO_2 \cdot nH_2O$), commercial refractory clays that are largely natural mixtures of kaolinite and quartz, and high alumina clays that are natural mixtures of diasporite and kaolinite.

TABLE I

Material	Quartz (%)	Total SiO_2 (%)
No. 81 pure sand*	98.02	99.26
Pa. siliceous fire clay	51.40	74.34
No. 98 plastic fire clay†	23.97	59.11
Pa. soft fire clay	9.28	50.52
Ga. kaolin	1.32	44.62
Montmorillonite‡	1.24	60.04
No. 97 flint fire clay§	0.38	42.87
Mo. diaspore clay	0.39	6.96
Mo. No. 1 burley clay	0.73	16.89
Kaolin + 10% No. 81 sand	10.97	50.08 (calculated)

*Glass sand, National Bureau of Standards sample No. 81.

†Plastic clay, National Bureau of Standards sample No. 98.

‡Smith County, Miss., bentonite high in montmorillonite.

§Flint clay, National Bureau of Standards sample No. 97.

It has been common practice in the past to calculate (instead of making direct determinations) the "excess silica" in fire clays, assuming that kaolinite is the clay mineral present. This practice may lead to errors as illustrated by the quartz found in the standard plastic and flint fireclay samples. Using the silica and alumina on the standard certificates for these samples, calculations show 29.17% "excess silica" for the plastic fire clay and 2.33% "excess alumina" for the flint clay. Actually, 23.97 and 0.38% quartz, or "excess silica," respectively, are present. The determinations of the quartz, therefore, are more dependable for finding the "excess silica" in a clay than calculations from the complete analysis.

V. Accuracy of Method

Any solution of the quartz will contribute a minus error to the method. The plus errors, however, are related to small quantities of the clay and of the associated minerals as well as the undissolved silicic acid found in the quartz. If the quartz that is separated is perfectly clean, the plus errors, of course, are negligible. It is impossible to determine accurately, by examination with the microscope, the amount of contaminating minerals remaining with the quartz because such minerals are present in extremely small amounts. Treatment of the separated quartz with HF, however, yields an index of the approximate contamination due to undissolved materials. If a residue was obtained after treatment of the quartz with HF, the weight averaged 0.9 mg. This is equivalent to an apparent plus error of 0.18%. By determining the weight of residue and inspecting its magnitude, it is thus possible to make a

[15] F. P. Treadwell and W. T. Hall, Qualitative Analysis, Vol. I, pp. 440–41, 6th ed John Wiley & Sons, Inc., New York, 1927.

rough approximation of the extent to which the accuracy of the determination has been affected by this factor. The weight of residue, however, does not disclose the amount of contamination from undissolved silicic acid.

It might be thought that the loss in weight, resulting from the HF treatment of the separated quartz and contaminating minerals, could be used to correct the quartz value. This procedure is not recommended because any silica present as clay or other silicate minerals contaminating the quartz is also volatilized and would give a high quartz value. Neither can the weight of residue after the HF treatment be used to correct the weight before treatment, inasmuch as the composition of the residue is uncertain. A quantitative analysis of the residue from each determination, furthermore, is not feasible because of the small quantity generally found.

The order of reproducibility of the procedure is indicated in the series of determinations on the samples shown in Table II. The quartz content in two instances was determined by a second laboratory. In all of the determinations given, the quartz was perfectly clean or the weight of residue did not exceed 1 mg.

TABLE II

Sample No.		Laboratory A Quartz (%)	Laboratory A Avg. deviation (%)	Laboratory B Quartz (%)	Laboratory B Avg. deviation (%)
1		9.20			
		9.20			
		9.30			
		9.40			
	Avg.	9.28	0.08		
2		9.92		9.7	
		9.98		9.6	
		10.10		9.8	
		10.14		9.8	
	Avg.	10.04	0.09	9.7	0.1
3		10.82			
		11.00			
		10.94			
		11.12			
	Avg.	10.97	0.09		
4		24.02		23.9	
		23.92		24.1	
				23.8	
	Avg.	23.97	0.05	23.9	0.1

To calibrate the procedure, it would have been ideal to have had samples of pure quartz available in which all the silica was free as well as the pure clay minerals in which all the silica was combined. Such materials, however, are not obtainable.

A pure glass sand, in the form of standard sample No. 81 of the National Bureau of Standards, was chosen as the criterion to test the method against solubility of quartz. The Bureau of Standards certificate does not show the silica content of this standard sample and the Bureau has not yet established the quartz content. The certificate, however, gives data on accurate determinations of numerous (possibly not all) accessory oxides present, which makes it possible to calculate a probable figure for the quartz content. The total silica by difference, for example, equals 99.26%. Alumina is present in an amount equal to 0.265%, and this, when calculated to kaolinite (the clay mineral most likely present), requires 0.31% silica which lowers the probable total free silica to 98.95%. The remaining accessory oxides, after deduction of the alumina, total 0.474%, but the amount of silica combined with these oxides has not been determined. From what is known concerning the major impurities in glass sand,[16] 0.25% more silica is likely to be present in the combined form, further lowering the free silica to 98.70%. The true quartz content, therefore, probably lies somewhere between the calculated value of 98.70% and the value of 98.02% found by actual analysis and shown in Table I. Disregarding the errors of analysis in the determination of the various accessory oxides and the quartz itself, 0.68% of the total quartz appears to have been dissolved.

This dissolved quartz probably is the fine fraction of the sample. A fraction consisting of particles 10 microns or finer, for instance, was separated from the original sample by a special sedimentation process. This fraction constituted 15% of the sample. It was not entirely quartz, however, for the total silica content equalled only 98.07%. This is due, presumably, to concentration of some of the impurities in this fraction. The remainder of the constituents, 1.93%, if assumed to be kaolinite, would require 2.27% silica, thus leaving 95.80% as the calculated quartz content. By actual determination, the quartz content was found to be 90.10%. The difference between the calculated value and that obtained by analysis is 5.70% and represents quartz in the fine fraction which has dissolved. The greater solubility of this fraction, therefore, would indicate that 0.15 times 5.70 or 0.86% of the quartz in the original sample had been dissolved. This value of 0.86% corresponds closely to the value of 0.68% actually found for the original sample.

Kaolin or montmorillonite may serve as standards to test the method against materials containing a high content of combined silica. The procedure appears to be satisfactory for this purpose, for in spite of a total silica content of 44.62 and 60.04%, only 1.32 and 1.24% of uncombined silica in the kaolin and montmorillonite, respectively, were found.

A synthetic mixture, consisting of 10% of the glass sand and 90% of the kaolin, yielded a quartz value of 10.97%. This figure checks closely the calculated value of 10.99%, using the quartz values for the sand and kaolin found by analysis and shown in Table I. Based on this test, the method is capable of distinguishing, with good approximation, between the percentages of free and combined silica in a mixture of the two.

The diaspore and burley clays of Missouri are considered generally to be mixtures of varying percentages

[16] J. E. Lamar, "Geology and Economic Resources of the St. Peter Sandstone of Illinois," *Ill. State Geol. Surv. Bull.*, No. 53, 175 pp. (1928); *Ceram. Abs.*, **7** [8] 575 (1928).

of the minerals, diasporite and kaolinite. The data in Table I are consistent with this conception and show that these highly aluminous refractory clays contain only small percentages of free silica as quartz.

The general accuracy of the method, as previously indicated, is dependent on a combination of minus errors owing to solution of the quartz and to the plus errors from contamination of the quartz. The minus errors, based on the results obtained with the standard glass sand, are proportional to the quartz present in the clay, and on this basis equal about 0.7% for a material which is approximately 100% quartz. The maximum apparent plus error, in the case of clays, will not exceed 0.2%, assuming only 1 mg. or less of quartz contamination. The maximum quartz that will be found in clays is probably about 50%. The net error in this case would be minus 0.15%. In a clay containing about 25% quartz, the errors are practically balanced. For clays containing 10% or less quartz, the net error would be about plus 0.13%. The magnitude of the errors, in general, would make check determinations fall within the limits considered to be satisfactory by Committee C-8 of the A.S.T.M. for Chemical Analysis of Refractory Materials (C18-37T).[17]

VI. Limitations of Method

The method has been applied thus far only to the more common unfired refractory clays. The value of the method for the high-temperature forms of crystalline silica and fired fireclay products remains to be studied. The materials, however, for which the method has been found applicable comprise some of the most important raw materials used in the refractories industries.

Acknowledgment

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[17] Proceedings of 40th Annual Meeting of the A.S.T.M., **37** [Part I] p. 760 (1937); *Ceram. Abs.*, **17** [7] 266 (1938).

DEFORMATION OF INSULATING FIREBRICK UNDER LOAD*

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ABSTRACT

An electrically heated furnace and a method to apply loads to full-size insulating firebrick heated throughout to thermal equilibrium are described. Sixteen commercial brands of insulating firebrick of various use limits were tested under several loads over a range of temperatures. No correlation was found to exist between the weight and the resistance to hot loading or between the cold crushing strength and the hot load-bearing capacity.

I. Object

The object of this work was to devise a suitable test procedure to measure the relative load-bearing resistance of insulating firebrick at various loads and temperatures. For convenience as a routine laboratory test, similar to the corresponding test for dense fireclay refractories, the test was made of such duration that it could be run in an eight-hour day. A test of this short duration, however, would not give sufficient information for complete engineering or design purposes because the rate of deformation decreases as the time of test is continued and a uniform rate is not established until the sample has been under load for several days. Obviously such long-time tests are not justified unless some special design features are being investigated in connection with hot load deformation. The foregoing remarks apply equally to insulating firebrick and dense firebrick.

The question of load-bearing resistance of insulating firebrick for ordinary wall constructions usually is unimportant. The temperature gradient through a lightweight insulating brick is so steep that the cool portion is able to carry the load even though the hot face has exceeded its load-temperature limit. There are many applications, however, in which insulating firebrick must withstand load conditions, such as insulated sprung arches of wide span, floors and car bottoms, metal holding furnaces, and parts of furnaces wherein insulating firebrick have been substituted for dense firebrick to reduce the weight of the furnace structure. The insulating brick in the latter case are sometimes heated on both sides so that the load-temperature conditions have been severe.

After selecting a suitable test procedure, the further object was to study the relationship of cold crushing strength and of bulk density to the load-carrying capacity when the brick are hot. To determine this relationship, sixteen brands of commercial insulating

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firebrick with widely differing properties were tested under the selected test procedure.

II. Method

Before establishing a test procedure, previous work by Phelps[1] was reviewed. He concluded that test brick should not be loaded when heated on all sides because the deformation is greater under these conditions than is encountered in normal wall construction wherein the high temperature is confined to one face of the brick only. For this reason, Phelps has recommended loading a wall which is heated on one face only. Because the cold part of the wall in this case supports the load, it is obvious that a test of this type cannot supply any information concerning the load-temperature conditions under which plastic flow results. It is also obvious that no relationships can be determined from such a test. For this reason, a test to be of value for the work outlined must be conducted on a sample which is heated on all sides.

In previous work on "soaking" heat load tests, the load was applied during a one and one-half hour soaking period. It was apparent that the center of the brick would not reach equilibrium until the temperature had been held for some time, thus reducing the effective loading time of the test. A variation in heating-up time would also cause a change in the temperature lag between the inside and outside of the test brick. To eliminate these two factors, the furnace temperature was balanced long enough to bring the inside of the test brick to equilibrium before the load was applied and then the load was applied for one and one-half hours.

To determine the temperature relation between the inside and outside of the test brick, thermocouples were placed in the center of the brick to determine how long a temperature-holding period would be required to bring the center to equilibrium conditions. Figure 1 shows the time-temperature relation between the inside and outside on a normal heating schedule. From these results, the furnace was brought up to the test temperature, the temperature was balanced for one hour, and the load was applied for one and one-half hours in all test runs.

III. Load Test Furnace

The furnace used in these tests had been used previously for testing dense firebrick (Figs. 2 and 3). It consists essentially of a rectangular furnace chamber heated by six $^3/_4$-inch Globar elements. Loading is accomplished by means of load beams with suitable knife edges and supports to reduce friction and arranged to give accurate vertical loading on the test brick. The lining of the furnace chamber is of insulating firebrick to reduce the heating-up time and to maintain a uniform temperature. In Fig. 2, four sighting windows are shown in the furnace casing, and opposite them are two reading telescopes, one of which has a filar micrometer eyepiece. This arrangement permits accurate measurement of subsidence of the test brick while at test temperature. When long-time tests are run, this method of measurement is necessary, but in the short-time test described here, the deformation was determined by measuring the test

[1] S. M. Phelps, "Properties of Insulating Refractories: I, Behavior Under Load at High Temperatures," *Amer. Refrac. Inst. Tech. Bull.*, No. 61, 6 pp. (December, 1935).

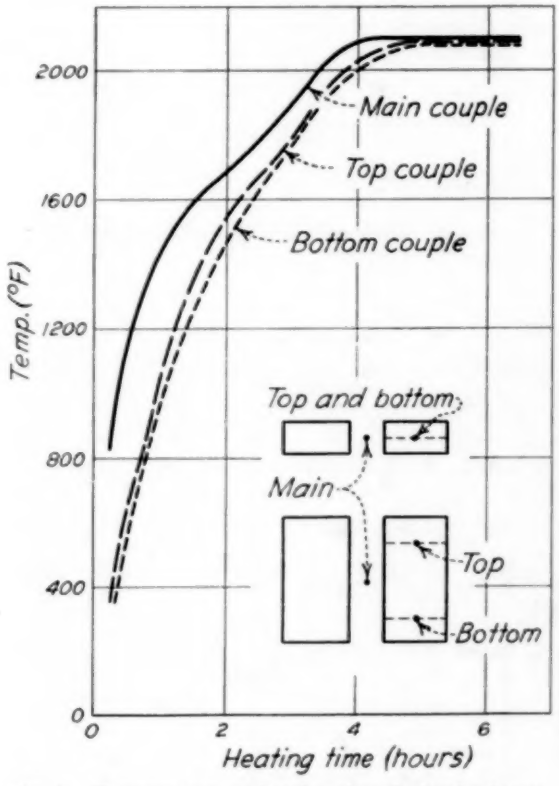

FIG. 1.—Temperature vs. heating time during load testing of insulating firebrick.

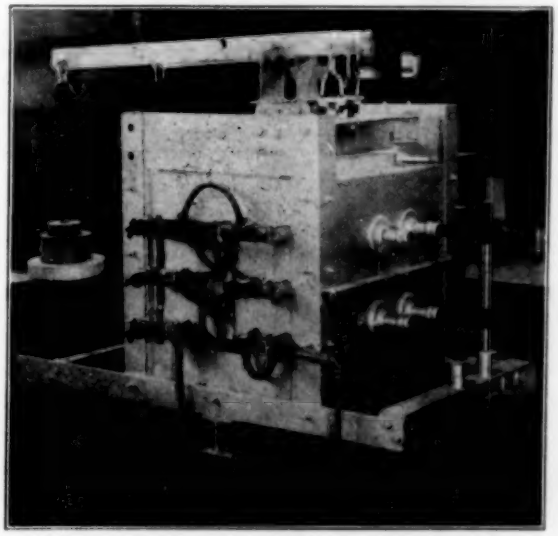

FIG. 2.—Electrically heated load test furnace.

brick before the run and again after the test was completed.

Furnace temperatures were measured by a platinum-platinum-rhodium thermocouple placed midway between the two test brick and protected by the usual porcelain tube.

IV. Procedure

The sample brick were measured carefully for length and were set in a vertical position on the $4^1/_2$- by $2^1/_2$-inch face. A fireclay brick was set upon this sample as a spacer and the loading assembly was completed (see Figs. 2 and 3). A slotted section of I-beam was used for the middle knife-edge support. The furnace was heated up, as shown in Fig. 1, held at test temperature for one hour, and then loaded by slowly lowering the unloaded beam onto its support and by applying the weights gradually. The temperature was maintained for one and one-half hours, after which the furnace was shut down and the samples were allowed to cool to room temperature under load.

TABLE I

TEST DATA ON COMMERCIAL INSULATING FIREBRICK

Brand	Use limit (°F)	Weight (lb./9 in.-straight)	Modulus of rupture (lb./sq. in.)	Cold crushing strength (lb./sq. in.)
A	2000	1.72–1.82	95	120
B	"	2.21–2.75	197	172
C	"	1.64	71	104
D	"	2.27–2.32	107	559
O	"	1.88	106	176
E	2200	1.87–1.96	165	193
F	"	2.71–3.07	224	377
G	"	2.27	129	208
N	"	2.44	66	235
I	2500	2.40–2.63	196	248
J	"	2.76	251	408
K	2600	2.30–2.50	133	128
L	"	2.68–2.80	203	372
S	"	2.40	127	196
M	2800	2.42–2.48	140	150
T	2900	2.90	235	220

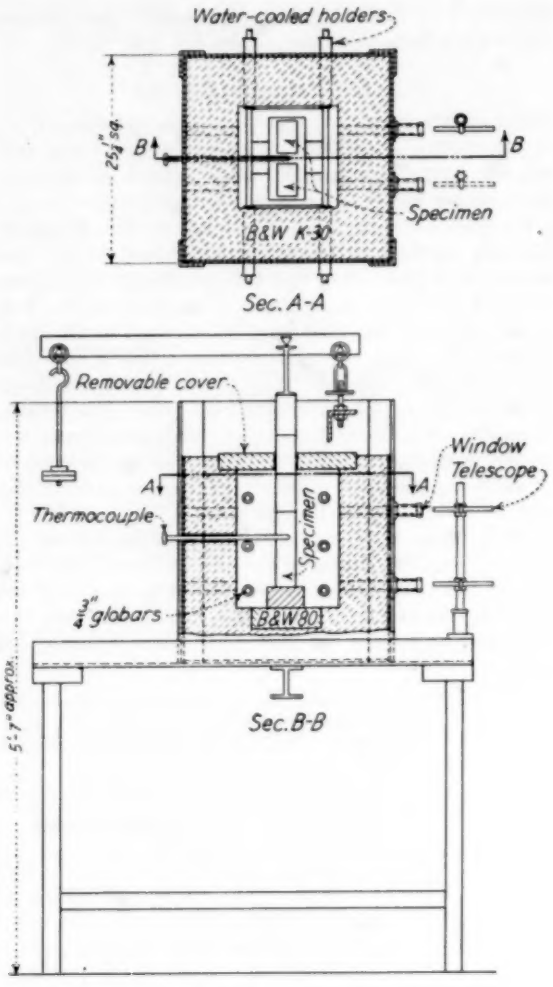

FIG. 3.—Electrically heated load test furnace.

TABLE II

LOAD TEST RESULTS

Firebrick brand	1900°F. 10 lb.	1900°F. 25 lb.	2000°F. 10 lb.	2000°F. 25 lb.	2000°F. 40 lb.	2100°F. 10 lb.	2100°F. 25 lb.	2100°F. 40 lb.	2200°F. 10 lb.	2200°F. 25 lb.	2200°F. 40 lb.	2300°F. 10 lb.	2300°F. 25 lb.	2300°F. 40 lb.
A			0.1%	0.1%	0.1%	0.0%	0.2%	0.3%	0.4%	0.7%	1.1%	1.1%	2.7%	Failed
B	0.1%	1.6%	0.6	8.3										
C	0.1	Failed	1.0	Failed										
D			0.9	1.3	2.5	2.5	2.9	4.9	3.8	Failed				
O			Failed											
E			0.1	0.0	0.1	0.0	0.1	0.2	0.1	0.1	0.4	1.6	2.6	Failed
F			0.1	0.4	1.8	0.2	2.5	7.6	2.5	Failed				
G			0.1	1.8	7.6	1.5	Failed							
N			Failed											
I			0.1	0.8	1.2	0.2	2.0	Failed	1.9	Failed				
J				0.2	0.2	0.0	0.2	0.7	0.1	1.7	Failed			
K						0.3	0.4	0.6	0.3	1.0	2.9	1.4	Failed	
L			0.0	0.2	0.4	0.1	0.9	1.6	0.9	1.2	5.5			
S			0.1	0.1	0.2	0.2	0.3	0.8	0.4	2.9	8.2			
M						0.0	0.4	0.9	0.1	1.0	3.9	0.4	1.3	Failed
T				0.1	0.2	0.2	0.1	0.4	0.2	0.4	0.6	0.3	0.8	0.9
No. 1											0.4			Failed
No. 2											0.2			

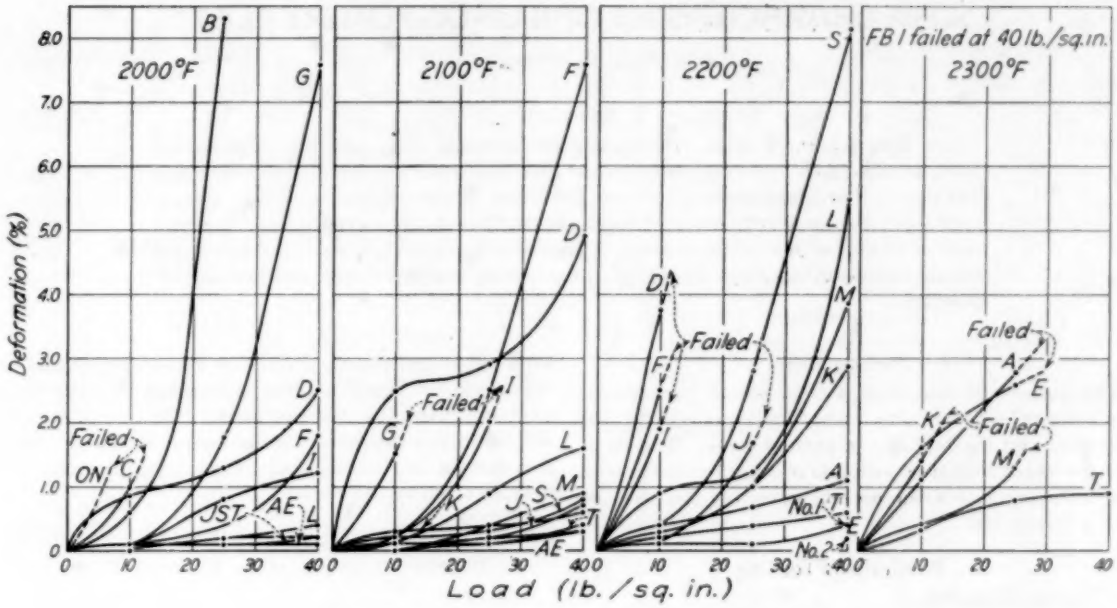

FIG. 4.—Deformation of insulating firebrick under load.

V. Samples Tested

Sixteen brands of commercial insulating firebrick were chosen to be representative of the various temperature groups The use limit, cold strength, and bulk density of these brick are listed in Table I. Two brands of dense second-quality fireclay brick were included for purposes of comparison.

VI. Results

The results obtained are shown in Table II. The loads were taken as 10 lb., 25 lb., and 40 lb. per square inch and the temperatures were 1900°, 2000°, 2100°, 2200°, and 2300°F. The deformation values are also shown in Fig. 4.

VII. Conclusions

There is no apparent relation from these results between cold strength and plastic flow. It might be concluded that a dense strong brick usually would carry more load when heated than the lighter and more fragile brands. This is not the case, however, inasmuch as some of the brands with the best load-bearing capacity are also among the lightest brands tested. The bulk density and cold strength, in general, do not indicate whether or not the brick structure is capable of withstanding hot-load conditions.

One point of considerable interest is that some brands of insulating firebrick can actually carry more load at the same test temperature than the two samples of dense firebrick tested. It is surprising that a refractory structure which consists of 80% solids will not stand as much actual loading as another refractory structure containing only 20% solids.

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SOME CHARACTERISTICS OF ILLINOIS POTTERY CLAY*

By C. G. Harman

Abstract

Four Illinois pottery clays, representing two extreme types and two intermediate types, are described. Porosity and thermal expansion tests were made on the raw and fired clays. The temperature of the inversion of low to high cristobalite in these clays is much lower than is usually accepted for the lower limit of this inversion because cristobalite is formed at low temperatures. A limited amount of data was obtained on the volume changes of raw clays during firing, the organic matter content, and thermal dissociation.

I. Introduction

The purpose of this work was to obtain information which might lead to a better understanding of some of the properties and the behavior of pottery clays. The clays were compared from the standpoint of a number of different properties, some of which are not ordinarily discussed in such a description.

II. Methods of Testing

(1) Thermal Expansions

Linear thermal expansion of the fired clays was determined by the method described by Westman[1] on specimens which were approximately one inch in diameter and nine inches long.

(2) Changes in Length During Firing

Air-dried bars were run in the thermal expansion apparatus; a current of air was passed through the furnace, and the heating rate was 200°C per hour.

(3) Thermal Analysis

Exothermic and endothermic reactions were determined by means of a Chromel-Alumel differential thermocouple. Artificial alpha alumina, as a reference material, was placed in one side of a divided Alundum crucible, and the clay in the other half. The temperature was increased at a linear rate of 6°C per minute. Temperature readings of the sample and of the millivoltage difference between the two sides of the crucible were made with a portable potentiometer.

(4) Permeability

Ten grams of clay to be tested were mixed with 50 cc. of water, allowed to stand overnight, and then thoroughly stirred and transferred to a 9-cm. Buchner funnel. The pressure in the flask was reduced to a few millimeters by an aspirator filter pump, and filtering was continued until no more free water remained on the surface of the clay. Fifty cubic centimeters of distilled water were poured on the clay in the funnel, and the time required for the water to filter through the clay was noted. The time of filtering was taken as a comparison of the permeabilities or "tightness of grain" of the raw clays. The temperature remained near 23°C during these tests.

Table I

Properties of Illinois Pottery Clays

		Clay No. (3)	(4)	(5)	(6)
Water of plasticity (%)		24.3	24.6	21.5	32.3
Vol. drying shrinkage (%)		17.7	17.9	17.7	36.7
Vol. pores/gm. dry clay (cc.)		0.158	0.150	0.128	0.135
Ratio of pore water to shrinkage water		1.86	1.56	1.47	0.72
Bulk specific gravity		2.09	1.86	2.03	
Porosity (%)	cone 02	22.2	19.2	18.8	12.6
	cone 2	9.8			1.5
	cone 9	1.3	8.0	10.3	1.0
	cone 12	0.0	0.47	2.8	0.28
	cone 14	15.0			0.2
P.C.E.		20	23	27	30

III. Description of Properties

(1) General Characteristics

The real basis for comparison of these clays, unfired, is the ratio of pore water to shrinkage water. This ratio is related to the permeabilities of the clays, and by inference, therefore, to the drying behavior.

The high shrinkage of No. 6 clay is due to its extreme fineness of grain, which causes a greater amount of water to become associated with the clay. These factors imply a high dry strength and bonding strength.

(2) Changes in Length During Firing

Figure 1 shows how the clays change in length during the early stages of firing. The α- to β-quartz inversion is indicated in curves for clays No. 3 and No. 5, but the curve for clay No. 6 shows no evidence of this mineral, although it is present in appreciable quantities. Clay No. 6 is typical of relatively pure and fine-grained clays, which show little swelling and permanent displacements of particles before and during dehydration.

Such curves are obviously significant in connection with firing.

(3) Thermal Expansion

The thermal expansions of the clays after they have been fired to cones 5, 9, and 12 are shown in Figs. 2, 3, 4, and 5. Three different types of expansion are represented

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* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 29, 1938 (Materials and Equipment Division). Received March 30, 1938.

This study was suggested by C. W. Parmelee, Head of the Department of Ceramic Engineering, University of Illinois. Most of the experimental work was carried out by P. E. Buckles, a student in the department.

[1] A. E. R. Westman, "Thermal Expansion of Fireclay Brick," *Univ. of Ill. Eng. Expt. Sta. Bull.*, No. 181 (1928); *Ceram. Abs.*, **8** [6] 416 (1929).

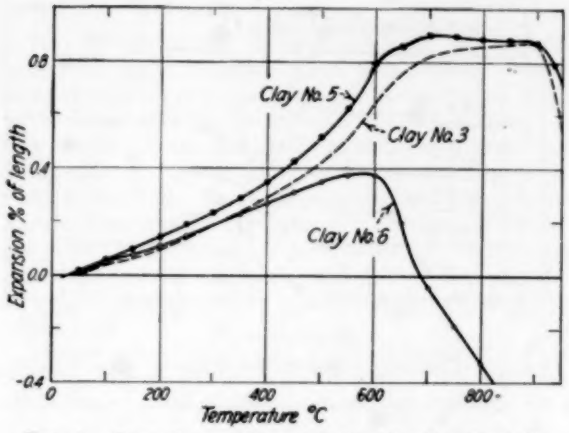

FIG. 1.—Raw clays; changes in length when heated.

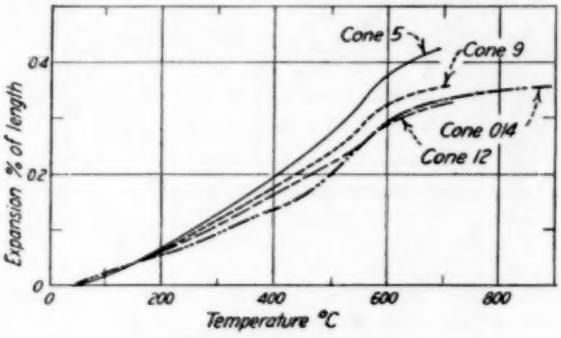

FIG. 2.—Clay No. 3.

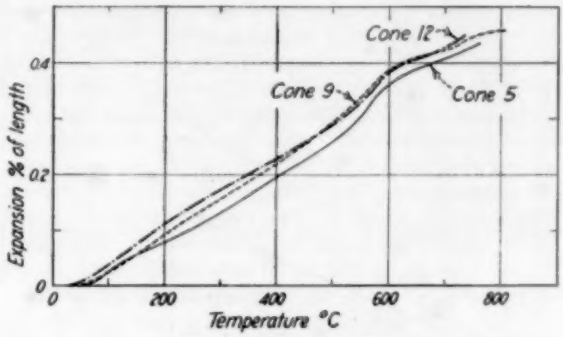

FIG. 3.—Clay No. 4.

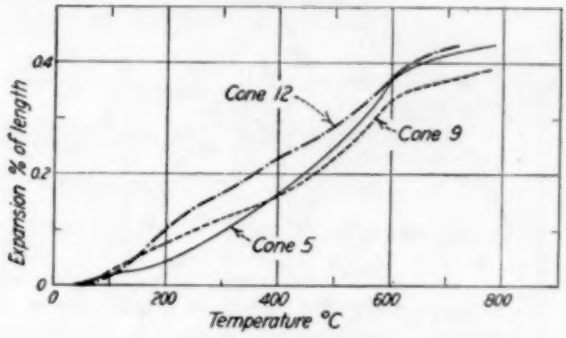

FIG. 4.—Clay No. 5.

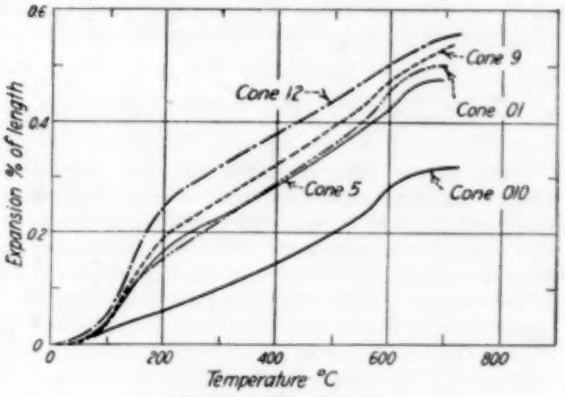

FIG. 5.—Clay No. 6.

by these curves. The expansion behavior of clay No. 3 is simple, the only inflection in the curves being the characteristic α- to β-quartz inversion. The lowering of the coefficient of expansion with each increase in firing was brought about by the increasing amounts of silica in the glassy phase without the formation of cristobalite. This is typical of clays rich in fluxes, particularly alkalis.

In clay No. 6, the expansion becomes greater as the firing temperature is increased, which is exactly the reverse of the behavior of the clay No. 3. The rapid expansion between 100° and 200°C was shown by X-ray diffraction patterns to be caused by the inversion of α to β cristobalite, although the inversion takes place about 100°C lower than the temperature customarily assigned to it because of the lower temperature formation of the cristobalite. The mutual relationship between the amount of cristobalite formed, its formation temperature, and its inversion temperature is shown in Figs. 3, 4, and 5.

At first it was thought that the copious development of cristobalite in clay No. 6 was due to the presence of one of the clay minerals richer in silica than kaolinite. X-ray examination failed to show the presence of any minerals except kaolinite and quartz and a trace of some unidentified mineral. The source of the cristobalite, therefore, must result from the inversion of the free quartz and the breakdown of the kaolinite to mullite and cristobalite.

The exceedingly fine-grained nature of the free quartz, together with the comparatively small quantity of fluxes present, explains the ready development of cristobalite. Note that the cristobalite development increases with the refractoriness of the clays.

Figure 6 illustrates how fluxes reduce or prevent the formation of cristobalite. The cristobalite content was reduced by 2% of $Na_2Al_2O_3$, and it was completely removed by a 6% addition.

(4) Thermal Analysis

The thermal analysis curves of a variety of different clays in Fig. 7 bring out a few characteristics of this type of data. The inverted peaks represent the endothermic effects associated with the loss of chemically combined water. The humps in the curves between 200° and 500°C represent heating effects caused by the combustion of organic matter.

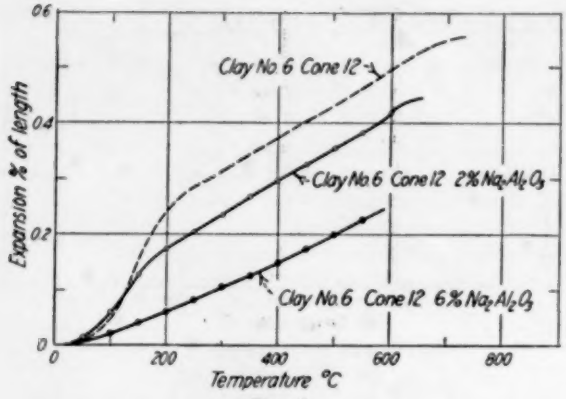

FIG. 6.

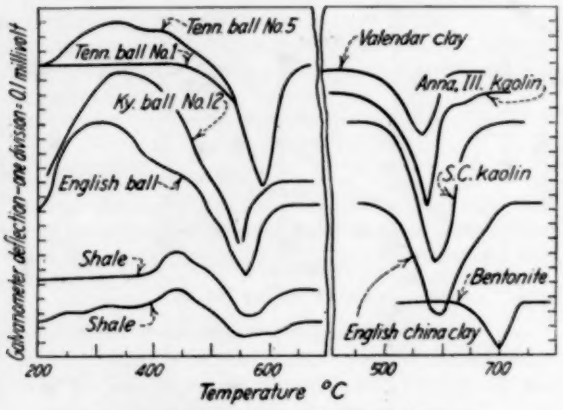

FIG. 7.—Typical thermal analysis curves

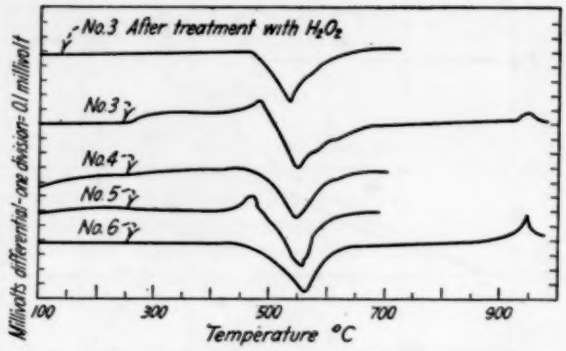

FIG. 8.—Thermal analysis curves of Illinois pottery clays.

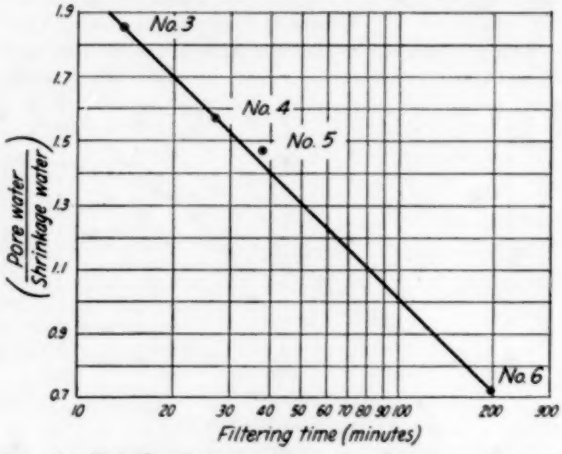

FIG. 9.—Relation between the ratio of pore water per shrinkage water to "permeability" or filtering time.

These curves differ in several respects. The endothermic reactions reach their peak at different temperatures and also vary in magnitude and breadth. The part of the curves which show the evolution of heat from the oxidation of organic matter differ in duration, intensity, and the temperature of maximum rate of heat evolution.

Too little is known regarding these thermal effects to permit their quantitative interpretation. Certain definite trends are evident, however, which may be interpreted qualitatively. These trends are illustrated by a comparison of Vallendar clay, South Carolina kaolin, Anna (Illinois) kaolin, and English china clay. The particle sizes of these clays increase in the order named, and there is the corresponding change in other properties, which are influenced by particle size. An increase in intensity, breadth, and peak temperature of the thermal lag can be noted with increase in particle size.

Thermal lag may be diminished by the presence of impurities as well as by the presence of clay minerals which do not show a marked absorption of heat. Based upon the meager data available, the presence of beidellite appears to reduce the intensity of the endothermic reaction as well as to shift the peak nearer to 550°C.

The thermal analysis curves of clays Nos. 3, 4, 5, and 6 are shown in Fig. 8. The peak of the thermal lag is at 550°C for clays Nos. 3 and 4, but it is 5°C higher for clay No. 5, and 10°C higher for clay No. 6. The intensity of the heat absorption indicates that all the clays are very fine grained, i.e., about the same order of magnitude as ball clays.

Two types of combustible matter are indicated in clay No. 3. The evolution of heat begins at about 250°C and continues mildly to about 450°C, where a more vigorous heat effect appears. Most of the organic matter in clay No. 5 is of the high-temperature oxidizing type, while clay No. 4 contains only material oxidizing at lower temperatures.

The quantity of organic matter as determined by oxidation with H_2O_2 is clay No. 3, 0.27%; clay No. 4, 0.16%; clay No. 5, 0.12%; and clay No. 6, 0.09%. A thermal analysis of clay No. 3 after treatment with H_2O_2 failed to show any heat evolution from combustion.

(5) Permeability

Clay No. 3 has a high ratio of pore water to shrinkage water, and the rate of movement of water through the clay is rapid (Fig. 9). Both of these characteristics indicate that the clay has desirable drying characteristics, which was found to be the case. Clay No. 6, on the other hand, has a low ratio of pore water to shrinkage water and a slow rate of water penetration. This clay is difficult to dry.

In the case of slip casting, the rate of casting would be proportional to the "permeability" time.

IV. Summary

Four Illinois pottery clays, representing two extreme types and two intermediate types, were studied. These clays tend to approach ball clays in characteristics. One of the clays differs from the ball-clay type only in color.

A measure of the permeabilities of the raw clays was obtained by timing the rate of passage of water through a definite layer of clay under standardized conditions. For the clays examined, there is a definite relation between permeability determined by this method and the ratio of pore water to shrinkage water. This type of data appears to classify the properties of the raw clays better than other simple tests.

As these clays were heated, rapid shrinkage began at 600°C in one clay and 900°C in two others. These points are of practical importance in connection with firing because the volume changes are quite rapid and the clays themselves are very weak at that point.

Three different types of thermal expansion behavior are represented by this collection of clays, viz., (1) no cristobalite inversion; the coefficient of expansion is lowered by each increase in firing temperature; (2) expansion increases with increase in firing temperature owing to the formation of considerable cristobalite; and (3) thermal expansion behavior is intermediate between (1) and (2). These characteristics are determined by the amount and grain size of free silica and by the purity of the clay.

Thermal analysis data furnish qualitative information on several characteristics of the clays studied.

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EFFECT OF ENAMEL ON THE STRENGTH OF ENAMELING IRON*

By A. I. Andrews and E. W. Dietterle

Abstract

Ground-coat enamel was first applied on one side and then on each side of 26-, 20-, 18-, 10-, and 6-gauge enameling stock, and the strengths of the pieces were determined in cross bending. The results show a decided increase in strength for the enameled specimens over that of the stock before enameling. An increase in the thickness of the enamel also increases the strength within limits. The effect on the lighter gauges is greater than on the heavy gauges, and the strength is greater when the enamel is under compression than under tension.

I. Introduction

Little experimental work has been done on the determination of the effect of enamel on the strength of the metal stock. This preliminary study of the subject therefore will probably be continued because it offers interesting information. In the present study, a sheet-iron ground coat was applied to 2- by 4-inch sheet-iron specimens, and the cross-bending strength was determined.

Because the thickness of the metal stock is an important factor in strength, the specimens were made with 26-, 20-, 18-, 10-, and 6-gauge stock. The thickness of the enamel was controlled by weighing. The enamel was sprayed on both sides of the metal in weights of 9, 18, 27, 36, 45, 54, and 63 grams per square foot, equivalent to 1, 2, 3, 4, 5, 6, and 7 grams per specimen; the area of each specimen, including both sides, was $^1/_9$ square foot. The enamel was also applied at 27 grams per sq. ft. to one side only of 18- and 20-gauge stock. All samples were dried and fired at 1580°F for an appropriate time to give good enamels.

The thickness of the stock and of the enamel plus the stock was measured. The specimens were then tested on a simple beam-action cross-bending machine with the load applied at the midpoint between a 3-inch span. The loads required to bend the specimens at gradually increasing deflections were recorded. The stress was also calculated, but because of uncertainty when a combination of materials is used the results are not included here. The specimens enameled on one side only were tested, both with the enamel side up as well as the enamel side down to obtain an indication of the importance of placing the enamel under compression or tension.

II. Discussion of Results

The results are indicated by the graphs (Figs. 1 to 6). With very thin-gauge stock, the different weights of enamel applied greatly increased the resistance to bending and the proportional limit of the specimen. As the thickness of the metal stock increased, the enamel applied did not play as important a part because the strength of the metal stock was much greater than the strength of enamel.

(1) Results of 26-Gauge Tests

The metal stock reached a yield point at about 0.2-inch deflection and had a maximum bending moment of 5.69 inch-pounds. The enameled specimen of 1 gram weight of enamel, however, showed a maximum bending moment of 10.50 in. lb. at this same deflection, which is 1.84 times the value for the metal stock. Enameled

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* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 31, 1938. Received March 31, 1938; revised copy received July 17, 1939.

specimens Nos. 2 and 3 showed an added increase over enameled specimen No. 1; specimens Nos. 4 and 5 had a bending moment of 15.7 in.-lb. at this same deflection, which is 2.75 times the bending moment of the metal stock. Specimens Nos. 4 and 5 also reached a yield point of failure at 0.35 inch deflection.

(2) Results of 20-Gauge Tests

The metal stock in this instance reached a yield point at 0.4 inch deflection and had a maximum bending moment of 27.97 in.-lb. At the proportional limit, 0.15 inch deflection, it showed a bending moment of 21.22 in.-lb. The enameled specimen with 1 gram weight of enamel at 0.4 inch deflection had a bending moment of 40.50 in.-lb. or 1.44 times the value of the metal stock. At 0.15 inch deflection, this same specimen had a bending moment of 31.50 in.-lb., an increase

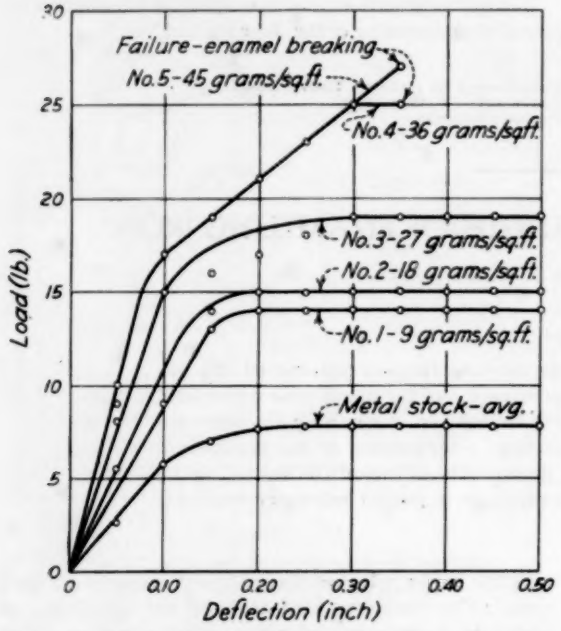

FIG. 1.—Effect of enamel on strength of 2- by 4-in., 26-gauge sheet steel.

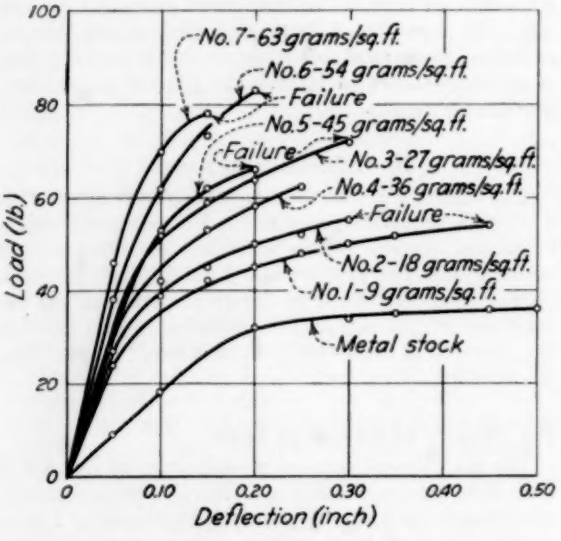

FIG. 2.—Effect of enamel on strength of 2- by 4-in., 20-gauge sheet steel. (Note: Curve No. 3 should read 36 gm. per sq. ft.; curve No. 4, 27 gm. per sq. ft.)

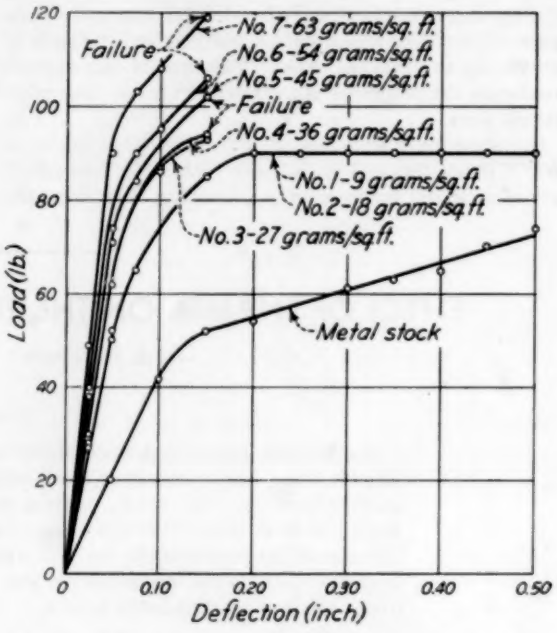

FIG. 3.—Effect of enamel on strength of 2- by 4-in., 18-gauge sheet steel.

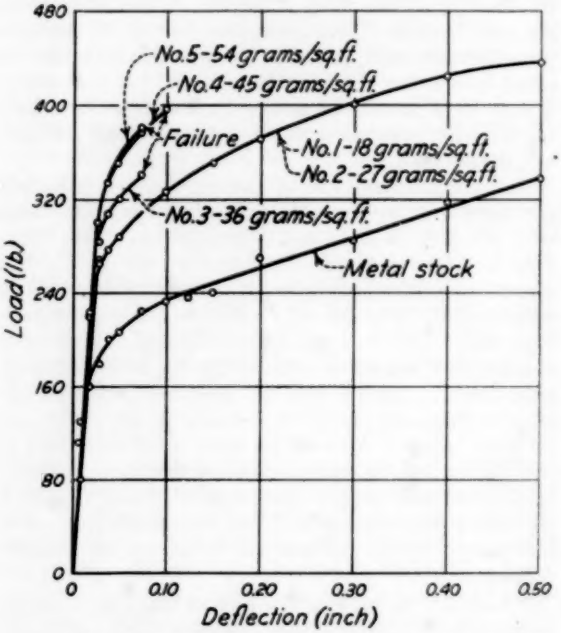

FIG. 4.—Effect of enamel on strength of 2- by 4-in., 10-gauge sheet steel.

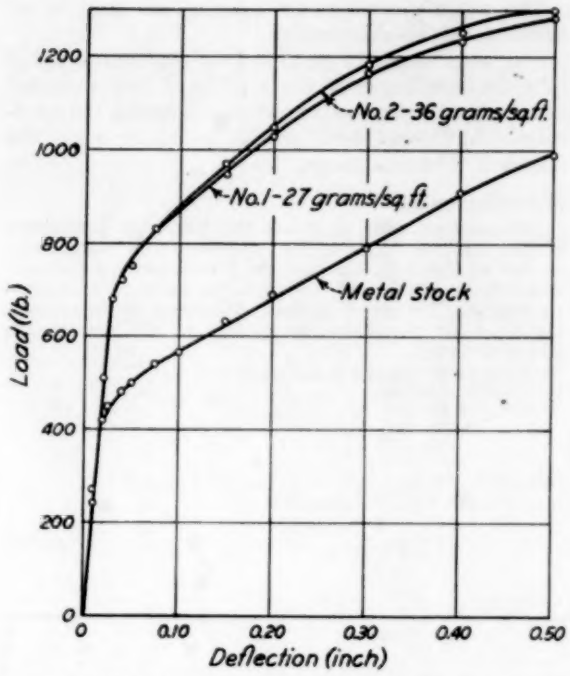

FIG. 5.—Effect of enamel on strength of 2- by 4-in., 6-gauge sheet steel.

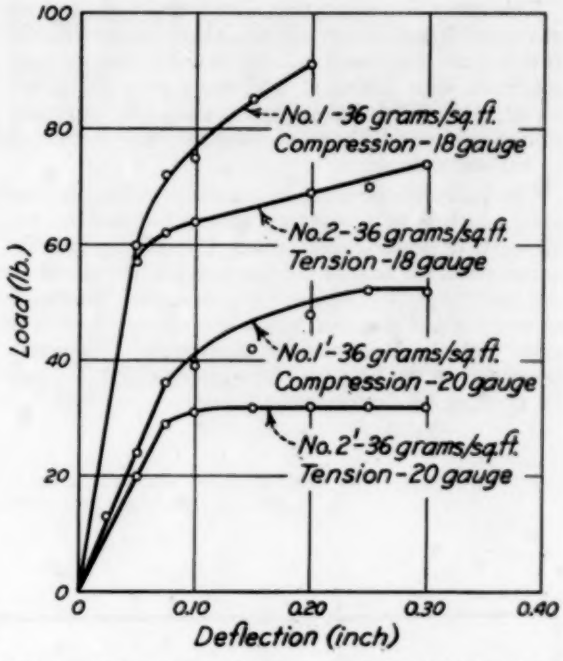

FIG. 6.—Effect of enamel on strength of 2- by 4-in., sheet steel.

of 1.48 times. Enameled specimen No. 7 with 7 grams weight of enamel had a maximum bending moment of 58.50 in.-lb., which is 2.75 times the bending moment of the metal stock at 0.15 inch deflection.

(3) Results of 18-Gauge Tests

The metal stock reached its proportional limit at 0.10 inch deflection with a bending moment of 31.20 in.-lb. Enameled specimen No. 1 with 1 gram weight of enamel had a bending moment of 37.50 in.-lb. at this same deflection. This is 1.20 times that of the metal stock. The other enameled specimens, with increasing weights of enamel, increased accordingly, and specimen No. 7 had a bending moment of 81 in.-lb. at 0.10 inch deflection, which is 2.59 times that of the metal stock at this same deflection.

(4) Results of 10-Gauge Tests

The metal stock had a bending moment of 127.50 in.-lb. at its proportional limit at 0.02 inch deflection. Enameled specimen No. 1 had a bending moment of 139.50 in.-lb. at this same deflection, giving a value 1.09 times that of the metal stock. Specimens Nos. 2, 3, 4, and 5 showed increases accordingly, and specimen No. 5, with 6 grams of enamel, had a bending moment of 172.25 in.-lb. at 0.02 inch deflection. This showed a value of 1.36 times that of the metal stock.

(5) Results of 6-Gauge Tests

The metal stock had a bending moment of 315 in.-lb. at the proportional limit of 0.02 inch deflection. Enameled specimen No. 1 had a bending moment of 382.50 in.-lb. at this same deflection, which shows a value 1.21 times that of the metal stock. Enameled specimen No. 2 had a bending moment of 397.50 in.-lb. at the same deflection, an increase of 1.26 times that of the metal stock.

Several sources of error are possible in these results, but the smooth nature of the curves and the general correlation of the results indicate that they are not very important. It is possible that the enamel was not always applied exactly in the same thickness on both sides of the specimen, which, in view of the results indicated by tension and compression tests and the importance of thickness, would contribute an error. Slight errors in reading the deflection and errors caused by the weight measurements, which were not sufficiently accurate, might also possibly introduce some error in the results but not great enough to invalidate the conclusions.

III. Summary

The experiment clearly shows that enamel applied to the surface of sheet metal greatly increases the strength of the specimen in thin gauges and to a less extent with the heavier gauges. Thus with 26-gauge stock the heavier applications of enamel nearly tripled the resisting force of the specimen, and even with the lighter applications, the resisting force was nearly doubled.

A comparison of the added strengths, resulting from different weights or different thicknesses of enamel, is obtained by comparing the bending moments. A calculation of the stress in pounds per square inch was unsuccessful because of the complicated distribution of stresses.

This study also shows that with a heavy application of enamel failure occurs within a short range of deflection because the enamel will chip or crack from the steel specimen, thus failing to add much strength to the metal stock. This indicates that there is a maximum thickness at which the enamel will give added strength to the metal stock.

The enamel is stronger in compression than in tension, which is in accordance with other data on the strength of ceramic materials. Considering the 20-gauge tests, the sum of the compression moment plus one half the tension moment approximately equals the moment of the specimen which was enameled on both sides with the same amount of enamel. This result, however, did not hold for 18-gauge tests, and it should be checked by further experiments.

The enamel increases the proportional limit in all instances of this experiment.

This work should be continued with different kinds of enamels, including cover coats. The problem may also be attacked by many other methods of testing the specimens. Additional tests should be made using the magnetic thickness gauge.

Acknowledgment

The authors wish to thank the Editorial Committee of the Enamel Division for criticisms and suggestions as well as Ralph L. Cook of the Department of Ceramic Engineering, University of Illinois, for his work in demonstrating that the heat treatment of the steel during enameling does not contribute perceptibly to the increase in strengths noted.

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SELL AMERICANS

Plant-to-Profit Clubs

Plant-to-Profit Clubs (see *The Country Home Magazine*, June, 1939) have changed 42,000 families and 200,000 persons from the ill-clad and ill-fed, hopeless, shiftless, sharecroppers to "heads-up" prosperous people, many of them now owning farms. This has been accomplished without federal or state aid. These people were sold on a system of self-help. Plant-to-Prosper farmers in nine of the erstwhile "one-crop cotton states" produced more than $20,000,000 in new crops.

Sell Americans the idea that American ceramic ware is "tops."

Sell American ceramists the fact that they "Plant to Profit" in ceramic knowledge by coöperating with the "up-and-going" ceramists through membership in

The American Ceramic Society

Sell American corporations on the fact that by a minimum investment of a $25.00 Corporation Membership in this Society they will profit as have the merchants, bankers, newspaper publishers, and industrialists of the South, who have derived large returns from their promotion of the "Plant-to-Prosper" clubs.

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Compiled by the

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JOURNAL REFERENCE: The journal name appears in italics, followed by the volume (bold-faced), issue number (in brackets), page numbers, and year (in parentheses).

January, 1940
19—1

Abrasives

Ceramic bonds for grinding disks and the Four-Year Plan. PAUL POSTEL. *Schleif- & Poliertech.*, **16** [2] 19–21 (1939).—Siboto compounds are substituted for borax-feldspar frits. Siboto A is a frit containing boron, sodium, magnesia, and lime (melting point 650°C). Siboto B contains boron, sodium, and barium (melting point 750°C). With these frits, any degree of hardness is obtainable. High firing allows suppression of foreign feldspar. F.E.V.

Construction and working of crushing plants for preparing electrocorundum abrasives. F. PUPPE. *Schleif- & Poliertech.*, **16** [6] 107–11 (1939).—Jaw crushers, final crushers, conveyers, elevators, edge runners, grinding mills, and sieves are described and discussed. 16 illustrations. See "Grinding—," *Ceram. Abs.*, **18** [5] 117 (1939). F.E.V.

Development of grinding- and polishing-machine construction as shown at the Leipzig spring fair, 1939. PAUL FELDMANN. *Schleif- & Poliertech.*, **16** [4] 68–77 (1939).—F. discusses dry grinding, high efficiency dry grinding, wet grinding, hard metal grinding, polishing, and high efficiency polishing machines. 21 illustrations. F.E.V.

Electrically heated furnaces for the grinding-wheel industry. F. HASSEL. *Elektrowärme*, **9** [9] 195–99 (1939).—Abrasive materials are almost exclusively made synthetically in the electric arc furnace (corundum, silicon carbide, coalite, etc.). The raw material, from finest powder to coarse pieces, is mixed with a binder and pressed into forms. Oil, lacquer, and magnesium chloride (magnesite) wheels bind at room temperature; rubber, Bakelite, synthetic resin, and sodium silicate bonded wheels are dried at 150° to 300°C; and wheels with ceramic binders are fired at 1100° to 1400°C after previous drying. Several electrically heated furnaces for the last group are described; a charge of 800 to 1000 kg. of wheels was fired in 144 hr. at 1250°C max. in a furnace using 1500 to 2000 kw.-hr. A smaller furnace consumed 120 to 150 kw.-hr. for a firing time of 24 to 48 hr. The furnaces are heated up to 1350°C by Fe-Cr-Al heating elements in muffles of sillimanite. The gases developed from the material in firing do not damage the heating elements. M.H.

SEPARATE PUBLICATION

Grinding Wheels. *Nat. Bur. Standards Simplified Practice Recommendation*, R45-39. Supt. of Documents, Govt. Printing Office, Washington, D. C. Price 10¢. This is a revision of *Recommendation* R45-32. R.A.H.

PATENTS

Abrading machine. A. N. EMMONS (Porter-Cable Machine Co., Inc.). U. S. 2,179,995, Nov. 14, 1936 (March 2, 1938).

Abrasive article. R. C. BENNER AND N. P. ROBIE (Carborundum Co.). U. S. 2,179,487, Nov. 14, 1939 (Oct. 29, 1937; renewed March 20, 1939).—An abrasive-coated article comprises a backing and abrasive grains attached thereto by a heat-hardened bond consisting principally of the reaction product of lignin, a phenol, and an aldehyde, containing not more than 40% lignin.

Abrasive article. S. S. KISTLER (Norton Co.). U. S. 2,177,940, Oct. 31, 1939 (Aug. 1, 1938).—An abrasive article comprises abrasive grains united by a rubber bond containing aniline-formaldehyde resin.

Abrasive article making apparatus. A. L. BALL AND A. G. SCUTT (Carborundum Co.). Can. 383,074, Aug. 1, 1939 (July 22, 1937). G.M.H.

Abrasive article and its manufacture. W. P. FITZRANDOLPH (Carborundum Co.). U. S. 2,173,833, Sept. 26, 1939 (Oct. 7, 1937).—An abrasive article comprises diamonds and a sintered metal bond consisting principally of tin, the bond containing a metallic alloying agent which hardens the tin.

Abrasive-coated sheet. N. E. OGLESBY (Behr-Manning Corp.). U. S. 2,173,796, Sept. 19, 1939 (July 6, 1936).

Abrasive disk. J. O. AMSTUZ (Behr-Manning Corp.). U. S. 2,175,073, Oct. 3, 1939 (Oct. 30, 1936; renewed Feb. 28, 1939).

Abrasive for grinding hard materials such as special steels. E. M. MONDINY AND F. M. GEFFROY. Fr. 840,356, Dec. 29, 1937. D.A.B.

Abrasive implement. L. V. REDMAN (Behr-Manning Corp.). U. S. 2,176,942, Oct. 24, 1939 (Aug. 19, 1927).

Apparatus for manufacturing diamond cutting tools. R. H. TAYLOR (J. K. Smit & Sons, Inc.). U. S. 2,174,904, Oct. 3, 1939 (March 29, 1938).

Articles comprising silicon carbide. W. J. TENNANT (Carborundum Co.). Brit. 513,728, Nov. 1, 1939 (April 11, 1938).

Balancing apparatus and method. R. N. JANEWAY (Chrysler Corp.). U. S. 2,177,830, Oct. 31, 1939 (Jan. 2, 1937).

Balancing machine. S. D. LIVINGSTON. U. S. 2,174,665, Oct. 3, 1939 (Feb. 27, 1930; May 2, 1936).

Bearing hone. J. J. PALOTCE. U. S. 2,178,491, Oct. 31, 1939 (April 3, 1939).

Bearings for shafts of grinding machines. BLACK & DECKER, LTD., AND F. W. MCCARTNEY. Brit. 511,802, Sept. 8, 1939 (March 19, 1938).

Buffing wheel. J. E. WELHAVEN (Advance Polishing Wheels, Inc.). U. S. 2,174,149, Sept. 26, 1939 (June 20, 1939).

Compound abrading and brazing machine. L. A. WILKIE (Continental Machines, Inc.). U. S. 2,180,078, Nov. 14, 1939 (May 27, 1935).

Continuous truing mechanism. B. A. KEARNS (Cincinnati Grinders, Inc.). U. S. 2,178,875, Nov. 7, 1939 (Sept. 3, 1937).

Convertible sawing and abrading machine. L. A. WILKIE (Continental Machines, Inc.). U. S. 2,180,079, Nov. 14, 1939 (Jan. 7, 1938).

Dressing screw-thread grinding disks. W. T. SCHAURTE AND K. KAUFMANN. Brit. 513,326, Oct. 25, 1939 (April 3, 1937).

Dressing and truing abrasive wheels. W. B. LOCKE (Ex-Cell-O Corp.). U. S. 2,176,350, Oct. 17, 1939 (June 6, 1938).

Drilling and honing machinery. J. C. CARLTON AND A. C. SPANGENBERG (Carlton Machine Tool Co.). U. S. 2,180,289, Nov. 14, 1939 (July 25, 1938).

Drill sharpener. G. W. FINKE (Bruno Concato). U. S. 2,177,644, Oct. 31, 1939 (July 26, 1937).

Finishing surfaces and machines therefor. NATIONAL BROACH & MACHINE CO. Brit. 513,677, Nov. 1, 1939 (Feb. 8, 1937).

Form grinding apparatus. C. G. FLYGARE (Norton Co.). U. S. 2,179,211, Nov. 7, 1939 (Dec. 12, 1938).

Form grinding machine. CLEMENT BOOTH (Cincinnati Grinders, Inc.). U. S. 2,178,848, Nov. 7, 1939 (July 16, 1937).

Gear grinding machine. C. G. OLSON (Illinois Tool Works). U. S. 2,176,924, Oct. 24, 1939 (Sept. 26, 1930; renewed Feb. 10, 1936).

Grinding. H. H. GILES AND C. M. NYSTROM (American Sheet and Tin Plate Co.). U. S. 2,177,316, Oct. 24, 1939 (April 11, 1936).

Grinding or abrading machines. S. A. HORSTMANN AND HORSTMAN, LTD. Brit. 512,225, Sept. 20, 1939 (July 6, 1938); divided out of 500,726, March 1, 1939. NORTON CO. Brit. 512,194, Sept. 20, 1939 (Aug. 16, 1937).

Grinding disk. HERMANN HIPPLE (Franz Forg). U. S. 2,173,555, Sept. 19, 1939 (Sept. 30, 1937).

Grinding machine. M. H. ARMS (Bryant Chucking Grinder Co.). U. S. 2,176,985, Oct. 24, 1939 (Oct. 27, 1933). R. H. CRAMER (General Motors Corp.). U. S. 2,176,248, Oct. 17, 1939 (June 16, 1936). N. N. SHEPHERD (Carboloy Co., Inc.). U. S. 2,176,726, Oct. 17, 1939 (May 18, 1938). F. R. SWANSON (Sundstrand Machine Tool Co.). U. S. 2,179,869, Nov. 14, 1939 (Jan. 18, 1937). J. G. THOMPSON (Norton Co.). U. S. 2,176,017, Oct. 10, 1939 (Oct. 30, 1937). FERNAND TURRETTINI (Société Genevoise d'Instruments de Physique). U. S. 2,174,146, Sept. 26, 1939 (Oct. 19, 1937).

Grinding or polishing device. NORMAN F. BROWN. Can. 383,167, Aug. 8, 1939 (April 16, 1938). G.M.H.

Grinding stone. J. E. HASSLER (Simonds Worden White Co.). U. S. 2,178,855, Nov. 7, 1939 (Feb. 19, 1938).

Grinding tool. J. Y. BLAZEK (Lempco Products, Inc.). U. S. 2,179,465, Nov. 7, 1939 (Dec. 9, 1938).

Grinding wheel. C. J. HUDSON (Norton Co.). U. S. 2,178,835, Nov. 7. 1939 (June 19, 1937).—An article comprises a plurality of bonded abrasive unidiameter sectors, cement securing the sectors together in the form of a wheel, and a peripheral band outside of the sectors and in a state of tension exerting a compressive force against them and comprising paper impregnated with resinoid, the article constituting a grinding disk, the plane face of which does the grinding and the peripheral band wearing away as the disk is used.

Grinding wheel. H. W. WAGNER AND K. F. WHITCOMB (Norton Co.). U. S. 2,173,462, Sept. 19, 1939 (Nov. 4, 1935; April 1, 1938).

Grinding wheel and method of grinding. H. W. WAGNER AND K. F. WHITCOMB (Norton Co.). U. S. 2,173,461, Sept. 19, 1939 (Nov. 4, 1935).

Grinding wheel truing apparatus. L. E. PAINE (Norton Co.). U. S. 2,178,842, Nov. 7, 1939 (Sept. 30, 1938).

Hone. T. H. NYE (Norton Co.). U. S. 2,175,158, Oct. 3, 1939 (June 29, 1938).

Honing machine. H. L. BLOOD AND W. D. SCHMIDT (Heald Machine Co.). U. S. 2,174,029, Sept. 26, 1939 (Oct. 2, 1936). A. F. BURGESS (Barnes Drill Co.). Brit. 513,649, Nov. 1, 1939 (March 25, 1938). F. A. SWANSON (Barnes Drill Co.). U. S. 2,176,316, Oct. 17, 1939 (July 21, 1937).

Hydraulic system for boring machines. W. D. SCHMIDT (Heald Machine Co.). U. S. 2,174,044, Sept. 26, 1939 (July 23, 1931; renewed July 15, 1936).

Lens-edging machine. E. M. LONG (Shuron Optical Co., Inc.). U. S. 2,175,719, Oct. 10, 1939 (Oct. 2, 1937).

Lens-grinding machine. JOSEPH SHANNON. U. S. 2,176,154, Oct. 17, 1939 (Dec. 1, 1936).

Machine for accurately grinding conical surfaces. H. F. ATKINS. Brit. 513,474, Oct. 25, 1939 (March 29, 1938).

Machine for performing abrading operations on shoes, etc. E. I. LA CHAPELLE (United Shoe Machinery Corp.). U. S. 2,177,025, Oct. 24, 1939 (April 8, 1937).

Machine for sharpening knives for plush and velvet cutting. WILLY TRÜJEN. U. S. 2,174,048, Sept. 26, 1939 (Jan. 29, 1937).

Manufacture of synthetic resin bonded abrasive articles. E. E. NOVOTNY (Durite Plastics, Inc.). U. S. 2,174,755, Oct. 3, 1939 (July 14, 1936).—A method of making abrasive articles comprises mixing abrasive grains with a resinous coating liquid and a pulverized potentially reactive resin in proportions to produce an initial wet mix, the coating liquid and pulverized resin having mutually reactive components whereby the initial wet mix produced converts itself upon standing to a dry moldable mix, forming the dry mix into abrasive articles, and hardening them.

Manufacturing abrasive articles. S. S. KISTLER (Norton Co.). U. S. 21,252, Oct. 31, 1939 (Sept. 14, 1939); reissue of 2,150,121 (*Ceram. Abs.*, **18** [5] 118 (1939)).

Manufacturing an artificial stone (having a support) to which an abrasive material is applied. H. SCHNEIDER (Julius Pintsch Kom.-Ges.). Fr. 848,809, Jan. 12, 1939. D.A.B.

Metallic article and its manufacture. J. A. BOYER, W. P. FITZ-RANDOLPH, AND C. G. ROSE (Carborundum Co.). U. S. 2,173,835, Sept. 26, 1939 (Oct. 7, 1937).—A metal bonded abrasive article comprises abrasive particles and a sintered bond consisting principally of an alpha solid solution in which the metal forming the basic lattice structure is a metal of the iron group and the metal retained in solid solution is of the group of low-melting amphoteric metals consisting of aluminum, zinc, and tin.

Method and apparatus for lapping bores. H. S. INDGE (Norton Co.). U. S. 2,178,448, Oct. 31, 1939 (Feb. 5, 1938).

Mounting for abrasive segments. H. P. KIRCHNER (Carborundum Co.). U. S. 2,177,549, Oct. 24, 1939 (Feb. 9, 1938).

Piston grinding apparatus. C. J. GREEN (Norton Co.). U. S. 2,179,213, Nov. 7, 1939 (Sept. 16, 1938).

Polishing and surfacing device. M. H. BISSELL. U. S. 2,173,350, Sept. 19, 1939 (March 1, 1937).

Precision grinding machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 513,405, Oct. 25, 1939 (April 22, 1939).

Process and apparatus for producing bevel-gear wheels. G. A. KLINGELNBERG, W. H. KLINGELNBERG, AND H. W. KLINGELNBERG (trading as W. F. Klingelnberg Sohne). Brit. 513,329, Oct. 25, 1939 (April 3, 1937).

Producing diamond grinding and lapping implements. GOTTLIEB BARTH-VUILLEUMIER. U. S. 2,174,453, Sept. 26, 1939 (Oct. 15, 1937).—In a method of producing diamond lapping implements, the steps comprise mixing diamond particles with particles of a hard mineral and with a ceramic binding material containing silicic acid, molding the mixture, and uniting the particles by firing the mixture.

Razor-blade sharpener. A. F. BELL (Behr-Manning Corp.). U. S. 2,177,922, Oct. 31, 1939 (Feb. 24, 1937).

Resilient abrasive blanket. C. B. SCHNEIBLE. U. S. 2,178,728, Nov. 7, 1939 (Oct. 27, 1937).

Rouging device for buffing wheels. C. R. MOON (Ontario Mfg. Co.). U. S. 2,177,992, Oct. 31, 1939 (June 23, 1938).

Saw-grinding machine. E. S. BUCHANAN (American Pearl Button Co.). U. S. 2,175,514, Oct. 10, 1939 (Aug. 4, 1937).

Segmental abrasive wheel. THURE LARSSON (Norton Co.). Can. 383,579, Aug. 22, 1939 (May 5, 1937; in U. S. May 14, 1936). G.M.H.

Segmental abrasive wheel. L. A. PATT (Carborundum Co.). U. S. 2,177,550, Oct. 24, 1939 (Feb. 23, 1939).

Silicon carbide and its manufacture. R. C. BENNER, R. L. MELTON, AND J. A. BOYER (Carborundum Co.). U. S. 2,178,773, Nov. 7, 1939 (Nov. 13, 1935).—(3) A method of making silicon carbide comprises continuously passing a mixture of sand and carbon through a tubular furnace chamber, the central portion of which is heated to at least the temperature of formation of silicon carbide, and maintaining the mixture out of contact from the walls of the furnace in the cooler portions of the furnace chamber, whereby the mixture is prevented from sticking. (7) A crude furnace product is composed of individually separated crystals of silicon carbide which are individually and separately developed and substantially free from faces produced by artificial fracture.

Silicon carbide product. OTIS HUTCHINS (Carborundum Co.). Can. 383,072, Aug. 1, 1939 (April 30, 1936). G.M.H.

Spindle reciprocating mechanism for grinding machines. B. A. KEARNS (Cincinnati Grinders, Inc.). U. S. 2,175,057, Oct. 3, 1939 (March 28, 1938).

Surfacing apparatus. LENIS HOLMES (B. F. Goodrich Co.). U. S. 2,174,385, Sept. 26, 1939 (June 18, 1937).

Tool for finish-grinding grooves in the interior of hollow bodies. MASCHINENFABRIK AUGSBURG-NÜRNBERG AKT.-GES. Brit. 512,103, Sept. 20, 1939 (Nov. 29, 1937).

Trimming mechanism for grinding wheels. S. G. BRADY (Gear Grinding Machine Co.). U. S. 2,178,135, Oct. 31, 1939 (Aug. 29, 1938).

Truing device for abrasive worms. ALFRED RICKENMANN. U. S. 2,177,583, Oct. 24, 1939 (March 11, 1939).

Valve grinding tool. B. H. DAVIS. U. S. 2,179,714, Nov. 14, 1939 (Oct. 29, 1936).

Waterproof abrasive article. H. R. STRATFORD (Stratmore Co.). U. S. 2,174,902, Oct. 3, 1939 (May 21, 1937).

Art and Archeology

American glass. M.B.D. *Bull. Metropolitan Mus. Art*, **34** [6] 161–62 (1939).—Examples of early 19th century American glass purchased by the Museum include a deep bowl of clear aquamarine glass typical of eastern Ohio workmanship and two spherical bowls. One, in the bluish green fabric associated with the known examples of New York glasshouses, has a bell-shaped cover. The other is of amber-colored glass and stands on a narrow crimped foot, suggesting the tradition of the glasshouses of southern New Jersey. A small salt cup, a typical example of offhand production, and a clear glass tumbler made in a patterned mold (a baroque shell pattern applied over the clear glass) are also included. A.A.A.

Art of the ancient Near East. HANNAH E. MCALLISTER. *Bull. Metropolitan Mus. Art*, **34** [8] 196–97 (1939).—The addition of gallery D8 to the section of the Museum devoted to the art of the ancient Near East provides space for many possessions not displayed permanently before. A case of prehistoric pottery contains jars with strangely shaped spouts, vases, and cups from sites on the Iranian plateau, most of them recently presented by the Museum of Teheran. A.A.A.

Art and industry. TILMANS. *Verre & Silicates Ind.*, **10** [17] 196–98; [18] 209–10; [19] 223–25 (1939).—The poor condition of the art industries is due partly to the lack or the slowness of the adaptability of manufacturers to the consumers' tastes and changing needs. Mechanization of the production of fine glassware, faience, and pottery, especially the decoration, has caused the disappearance of skilled artisans and specialized handicraftsmen, who personalized their work and frequently contributed innovations. The directors of the industry, therefore, who are frequently indifferent to taste and quality, must originate styles or replace models. It is not sufficient to dress old objects and old ideas in the taste of the day; it is necessary to create new demands and necessities yet unknown. Quality, fine taste, and originality are vital in the art industries where ideas and inventions must be constantly renewed. When beauty and art are made comprehensible, the public manifests its instinctive tendency toward discriminating appreciation. The direction of a complex industry cannot be combined with creative activity. The art industries must either face extinction or find formulas for renewal under the judicious protection of the state. The artists must also do their part; they must cease purposeless creation and dedicate their talents to the greater service of the artistic direction of industry. This requires special adaptation of the creative instinct and knowledge of the limitations of media and technique. To obtain specialized training, artists should be aided by endowments because apprenticeship alone is inadequate preparation. The reciprocal obligations, rights, and duties of artist and industrialist should be regulated by the state and other organizations. The fairest system of collaboration is that of the payment of royalties to the artist on each piece sold; according to T., a sculptor, this method is also beset with pitfalls, especially for the artist who is a victim of his lack of business acumen, candor, and trust. The custom of the artist signing his work should be adopted; this acts as an incentive to maintain a higher standard of work. M.V.C.

Bequest of Jacob Ruppert; Far Eastern art. ALAN PRIEST. *Bull. Metropolitan Mus. Art*, **34** [7] 172–74 (1939).—The bequest of Jacob Ruppert includes seven examples of pottery and porcelain and two glass bowls. The pair of 19th-century Chinese glass bowls, with opaque white grounds decorated with plum branches, birds, and a conventional border in green relief, is a valuable addition. Characteristic examples of Ming ware (1368 to 1644) are (1) a fine gourd-shaped vase 19 in. high of the type known as "three-color porcelain," (2) a pair of melon-shaped jars enameled in yellow with a green leaf pattern in high relief, and (3) a reticulated pottery jar with green ground decorations and dragons and lotus flowers in blue, yellow, and aubergine. The finest piece is an 18-in. porcelain jar of the Yung Chêng period (1723 to 1735) with its magnificent dragon in overglaze iron red superimposed on the more conventional pattern of waves and clouds in underglaze blue. The bequest also includes a large *famille verte* jar, a porcelain bottle with an allover peony pattern in underglaze blue and copper red, and four medallions with garden scenes reserved in blue and white which belong to the K'ang Hsi period (1662 to 1722). A.A.A.

Bicentenary of Richard Adams, master potter. ANON. *Jour. Roy. Soc. Arts*, **87** [4522] 936–37 (1939); see *Ceram. Abs.*, **18** [9] 259 (1939). K.R

Chain of the Order of St. Andrew. HELEN COMSTOCK. *Connoisseur*. **103** [454] 340 (1939).—A rare 18th-century

enameled chain in the Hammer Galleries is executed in enamel and gold and consists of 23 medallions. M.E.P.

Colors of Edward. ANON. *China, Glass & Lamps*, **59** [2] 9–10 (1939).—Color and combinations of color in chinaware and art pottery greatly influence interiors. J.F.

Copenhagen porcelain. ANON. *Sprechsaal*, **72** [35] 454–55 (1939).—In the 1880's a new type of Danish porcelain revolutionized the occidental art porcelain industry. The oriental types of vases and bowls with smooth surfaces were painted with simple, yet unsurpassed, nature studies of the native north country. Water, sky, plant, and animal subjects were pictured in delicate, unobtrusive colors. Arnold Krog developed a new process of underglaze painting. A distinctive type of animal sculpture also appeared. Modern trends in Danish ceramic art follow the same traditions, but the white Copenhagen porcelain with its delicate glaze and the pale underglaze paintings in a few tones has been supplemented by porcelain with celadon glazes (similar to jade green) and a porcelain from a subdued gray paste; white, cream, or delicate blue bowls and vases with opal-like surfaces, frosted glass or crazed glazes, greenish figurines, sea blue cups, etc., show perfection, originality, skill, and painstaking care. M.V.C.

Drinking glasses of exceptional beauty. BRUNO MAUDER. *Glashütte*, **68** [49] 841–43 (1938).—Distinctive drinking glasses are shown. Handwork and hand blowing have a great part in the production of fine glass. The value of any piece can be increased by clever workmanship. The examples described are thin blown bell-shaped glasses on long finely wrought stems, some of which show a rich profile with single or double hollow knob inserts which require every technical skill to produce; other stems are fluted for strength. They are the combined work of the artist and the skilled technician. Unfortunately, such pieces are rare, and their production must be safeguarded and means must be sought to make the handwork easier and quicker, to increase output, and to lower the cost. M.V.C.

Eighth National Ceramic Exhibition prize awards. ANON. *Bull. Amer. Ceram. Soc.*, **18** [11] 439–41 (1939).

Fifteenth and sixteenth century painted glass in north-west Essex. F. SYDNEY EDEN. *Connoisseur*, **104** [455] 22-27 (1939).—The heraldic glass (roundels and heads of saints) found in ancient parish churches is described. Much of it is fragmentary, but repairs have kept it interesting. A few examples of domestic glass windows are mentioned, most of which are painted in grisaille. Illustrated. See "Medieval—," *Ceram. Abs.*, **17** [11] 347 (1938). M.E.P.

Fourteenth century prayer niche of faience mosaic. M. S. DIMAND. *Bull. Metropolitan Mus. Art*, **34** [6] 136–37 (1939).—Among the ceramic techniques which the Mohammedan potters perfected or invented, faience mosaic is peculiar to Mohammedan Iran. Since the 13th century, faience mosaic has been used in the decoration of buildings. In the production of these mosaics, huge slabs of earthenware glazed in solid colors were cut into small units following the contours of the design. They were placed face down on the pattern, and the back of each piece was cut to a tapering edge to allow the plaster filling to penetrate all the spaces between. A great masterpiece of faience mosaic recently acquired by the Museum is a large 14th-century mihrab or prayer niche, which was shown for the first time in 1931 in the London exhibition of Persian art. This mihrab is very rare, as only two are known in Iran. A.A.A.

German glass artists in old Sweden; names and work. BRUNO ROEMISCH. *Sprechsaal*, **72** [36] 465–67 (1939).—Glassmakers were recorded in Sweden for the first time in 1415, but glassmaking was practiced on a small scale in the Middle Ages and glass objects were a luxury. Interest in the use of glassware became greater in the 16th century, and in 1544 King Gustaf Wasa sent to Germany for glassmakers and other handicraftsmen. German glassmakers and imported German glassware had a decided influence on the Swedish glass industry until the 19th century. Among the most important German artisans in Sweden in the 17th century were Antony Seifferd and Christoph Elstermann, who originated the Elstermann school of decorative art. Other names are mentioned. M.V.C.

Glass fish for the aquarium. ANON. *Pottery & Glass Record*, **21** [8] 214 (1939).—Glass fishes made in Thuringia form novel ornaments for small aquaria and for shop-window attractions. They were shown at the 1939 autumn fair at Leipzig. A.B.S.

Greenwich House pottery. C. L. A. *Bull. Metropolitan Mus. Art*, **34** [9] 218–19 (1939).—The group of contemporary American ceramics shown in Gallery J8 includes exquisite porcelain made by Adelaide Robineau and pottery by Henry Varnum Poor. Carl Walters' work is represented by playful animals. Two examples of Greenwich House pottery have been added to this collection. One is a plate by Juanita Gonzales which derives its charm from the warm reddish tone of the clay, the harmonious coloring, and the free drawing of the design. The other piece is a plate by Lucille Villalon with a simple incised design; it is covered with a combination of lead and alkaline glazes shading from rich turquoise to a cool celadon. A.A.A.

Gregory ceramic. ANON. *Magazine of Art*, **30** [12] 746 (1937).—Waylande Gregory's terra-cotta sculpture, "Struggle," which won a special award of merit at the National Ceramic Exhibition at the Syracuse Museum, is illustrated. M.E.P.

Incalculable record. ANON. *Magazine of Art*, **32** [8] 461–71 (1939).—Two ceramics are illustrated: "French Poodle" by Walt Speck (Michigan) and "Midsummer Morning" by Edris Eckhardt (Ohio). M.E.P.

Late Helladic gilt terra cottas. CHRISTINE ALEXANDER. *Bull. Metropolitan Mus. Art*, **34** [9] 216–17 (1939).—A necklace and a statuette of a goat in gilt terra cotta, both said to be from Mycenae, have been acquired by the Museum. The necklace belongs to the third Late Helladic period (1400 to 1100 B.C.) and consists of thirteen identical rosettes and a pendant in the shape of a conventionalized lily. The goat statuette is of similar red clay covered with gold leaf and may be contemporary with the necklace. It has been impossible to place it definitely. A.A.A.

Limoges candlesticks. JOHN GOLDSMITH PHILLIPS. *Bull. Metropolitan Mus. Art*, **34** [6] 138–40 (1939).—Two handsome Limoges enamel candlesticks signed with the initials I.C. have been presented to the Museum. Illustrated. A.A.A.

Limoges enamels of the Walters collection. HELEN COMSTOCK. *Connoisseur*, **103** [454] 337–38 (1939).—C. reviews a special exhibition at the Baltimore gallery consisting of 150 secular and ecclesiastical pieces representing Nardon Pénicaud, Léonard Limousin, Pierre Reymond, Pierre Corteys, Susannah Court, Jean Court, Nicholas Novaillier, and members of the Laudin family. Two examples of Pierre Reymond's 16th-century plates are illustrated. M.E.P.

Manufacture of Sèvres in the 18th century. GEORGES HAUMONT. *Céram., Verrerie, Email.*, **7** [5] 165–70; [6] 197–204; [7] 231–32 (1939).—The history of Sèvres manufacture during the 18th century is divided into four periods: (1) 1738 to 1756: In 1738 two obscure artisans, the Dubois brothers, with their friend, Gravant, founded the Porcelain Factory of France at Vincennes. This was the 14th French factory. During this period the work gradually became better organized and expanded until in 1750 there were 7 workshops and about 110 workmen. The collaboration of fine painters with skilled craftsmen produced little masterpieces which included the "Grape Eater," the groups of "Boucher" children, the "Jealous Group," and porcelain flowers painted *au naturel*. The Vincennes factory also made pieces of table service, copying the Chinese productions and occasionally the Saxony style of decoration. (2) 1756 to 1772: In 1756 the factory was moved to the new location at Sèvres and became royal property. This was the most brilliant period of the Royal factory which led all other European factories. Before 1770, when kaolin deposits in French territory were discovered, French factories produced no porcelain similar to that of China, Germany, and Saxony but rather a porcelain composed of glass mixed with white earths imperfectly

dispersed in the fused glass. Germany had used kaolin since 1710, and the Factory of Meissen was established in a fortress with the death penalty imposed on any who revealed its secrets. In 1727 Reaumur analyzed Chinese porcelain, and the search for kaolin deposits in France began. Large quantities were finally found at Saint Yriex, and the French "hard" or "royal" porcelain was originated. The new paste rivaled that of China and was the glory of French ceramics; Louis XV offered Sèvres porcelain to the Emperor of China. Ornamental figures, vases, and jars in complicated forms were made during this period, but they were of small dimensions because the paste did not lend itself to the modeling of larger pieces. "The Bather" was one of the most celebrated bisque figures produced by the Royal Factory. (3) 1772 to 1792: The most striking feature of Sèvres manufacture under Louis XVI was the production of the great tableware services. With the decline and fall of the monarchy, the activity of the factory slowed. Busts of men of the day were popular, but the bisques of the 18th century died with the monarchy. (4) 1792 to 1800: The Sèvres Factory was in a critical condition until the establishment of the Directoire in 1795, when activity was resumed. Sèvres porcelain of the 18th century is characterized by grace, elegance, and the life-like quality of the figurines, which reflected the intimate life of the epoch. M.V.C.

Mapungubwe. G. Caton-Thompson. *Antiquity*, **13** [51] 324–41 (1939).—The prehistoric pottery is Bantu (negro) and has affinities with modern Bantu and not with Hottentot or Bushman ware. See *Ceram. Abs.*, **12** [9] 321 (1933). A.B.S.

Mexican crafts. Ruth W. Lee. *House Beautiful*, **81** [10] 66, 67, 133 (1939).—Pottery decoration is taken from symbols of the archeological ruins of the homeland or from legends. Illustrated. J.F.

Clara Chipman Newton, pioneer secretary, Rookwood Pottery Co. Anon. *Bull. Amer. Ceram. Soc.*, **18** [11] 443–45 (1939).

Painting on glass. J. D. *Bull. Metropolitan Mus. Art*, **34** [9] 217–18 (1939).—Among engravings sent to China for reproduction on glass was one known as "Liberty in the Form of the Goddess of Youth giving support to the Bald Eagle" from a copperplate made by Edward Savage in Philadelphia in 1796. The most complete and perfect painting of the subject yet seen is shown in the Room of Recent Accessions. A.A.A.

Porcelain League of Cincinnati. Clara Chipman Newton. *Bull. Amer. Ceram. Soc.*, **18** [11] 445–46 (1939).

Rare souvenirs of King George III and Queen Charlotte. Bellamy Gardner. *Connoisseur*, **104** [455] 19–21 (1939).—These rare souvenirs include two Wedgwood ware medallions showing portrait busts of the King and Queen and a single opera glass of Wedgwood ware. M.E.P.

Ras Shamra. T. H. Gaster. *Antiquity*, **13** [51] 304–19, 356–59 (1939).—Brief references to the prehistoric pottery (2000 to 1000 B.C.) on the north coast of Syria and its stratigraphic locations are contained in a report on the excavations made at Ras Shamra and Ugarit from 1929 to 1939. A.B.S.

Russian decorative arts. Helen Comstock. *Connoisseur*, **104** [455] 38 (1939).—An enameled and silver gilt jewel casket made by the Russian court silversmith, Ovchinnikov, in 1889 is described and illustrated. The sides are lapis lazuli overlaid with pierced arabesques in gold with insets of enamel flowers in pink and blue, shaded by hand. M.E.P.

Stained-glass window. Anon. *Pottery & Glass Record*, **21** [8] 199–201 (1939).—A new stained-glass window commemorating the coronation of King George VI and Queen Elizabeth, designed by Hugh Easton of Cambridge, has just been erected in Winchester Cathedral. It shows the King and Queen kneeling, holding their crowns, and looking at a central scene depicting the Marriage at Cana in Galilee. In the background are heraldic details. The king is robed in rich blue with a cap of red, and the Queen's robe is of deep green, touched with red and yellow and relieved by a silver badge. The heraldic lions in the background are in yellow, silver, and ruby. A.B.S.

BOOK

Prehistoric Macedonia. W. A. Heurtley. Macmillan Co., New York, 1939. 275 pp., 112 illustrations, 23 plates. Price $18.—H. presents an archeological reconnaissance of Greek Macedonia (west of the Struma) in the Neolithic, Bronze, and early Iron Ages. He describes excavations carried out between 1924 and 1932 and collects and arranges the material obtained. Finds are classified according to their period, and within each period by areas, to give a detailed view of the various cultures of Macedonia; with the help of the index, the complete history of individual sites can easily be obtained. The book forms the most thorough account of the prehistory of Macedonia so far attempted; it makes substantial additions to our knowledge of the area and coordinates this new material with the results of previous work.

PATENTS

Bottle. Cristalleries du Val St.-Lambert (Soc. Anon.). Fr. 849,133, Jan. 19, 1939. D.A.B.

Designs for:

Ashtray. E. W. Fuerst (Libbey Glass Co.). U. S. 116,843, Sept. 26, 1939 (Dec. 24, 1938).

Bottle. B. D. Fuerst. U. S. 117,617, Nov. 14, 1939 (Aug. 25, 1939). R. A. Blunt. U. S. 117,605 to 117,609, Nov. 14, 1939 (Nov. 7, 1938). T. D. D'Addario (Nehi Corp.). U. S. 117,610, Nov. 14, 1939 (July 5, 1939). J. L. Dunnock (Swindell Bros., Inc.). U. S. 117,259, Oct. 24, 1939 (June 24, 1939). P. P. Mülhens. U. S. 117,659, Nov. 14, 1939 (Aug. 24, 1939).

Bottle. Shirriff's, Ltd. Can. 12,501, Aug. 19, 1939. G.M.H.

Coffee maker. H. G. Lehmann (Casco Products Corp.). U. S. 117,568 to 117,571, Nov. 14, 1939 (June 24, 1939).

Creamer. Charles Kaiser (Morimura Bros., Inc.). U. S. 117,372, Oct. 31, 1939 (June 21, 1939).

Dish. E. B. Bedford and Pascal L'Anglais (Oneida, Ltd.). U. S. 116,733 and 116,734, Sept. 19, 1939 (Aug. 12, 1939).

Glass cake plate. F. S. Barbiers (Anchor-Hocking Glass Corp.). U. S. 116,791, Sept. 26, 1939 (July 3, 1939).

Glass fruit bowl. F. S. Barbiers (Anchor-Hocking Glass Corp.). U. S. 116,790, Sept. 26, 1939 (July 3, 1939).

Glass lotion bottle. 303 Chemical Co., Ltd. Can. 12,479, July 15, 1939. G.M.H.

Glass muffin tray. F. S. Barbiers (Anchor-Hocking Glass Corp.). U. S. 116,788, Sept. 26, 1939 (July 3, 1939).

Glass sandwich plate. F. S. Barbiers (Anchor-Hocking Glass Corp.). U. S. 116,789, Sept. 26, 1939 (July 3, 1939).

Plate. Doris Johnson (Mayer China Co.). U. S. 116,743, Sept. 19, 1939 (Jan. 14, 1939). R. A. Kelly (U. S. Glass Co.). U. S. 117,374, Oct. 31, 1939 (Feb. 23, 1938). J. H. Wilson (National Toddle House Corp.). U. S. 117,387, Oct. 31, 1939 (Aug. 25, 1939).

Punch bowl. R. A. Kelly (U. S. Glass Co.). U. S. 117,373, Oct. 31, 1939 (Feb. 23, 1938).

Spark plug. A. C. Lipp (B. F. Goodrich Co.). U. S. 117,232, Oct. 17, 1939 (Aug. 30, 1939).

Cements

Blast-furnace slag and cement. R. Grün. *Umschau*, **43** [28] 655–57 (1939). J.M.N.

Blast-furnace slag and its use in the cement industry. Anon. *Verre & Silicates Ind.*, **10** [22] 253–55; [25–27] 290–92 (1939).—Slag, a by-product of the steel industry, results from the fusion of the gangue of iron minerals, limestones added as fluxes, and coke used for fuel. Fused slag leaves the furnace at a temperature of 1400° to 1500°; it

cools slowly, and gases absorbed during fusion are liberated, leaving a cellular structure. Acid slags with high silica content tend to vitrify with the formation of few crystals; basic slags crystallize easily and are lighter in color. A high lime content and a high alumina content are believed to favor granulation and hydraulic properties. When slag is cooled rapidly in water, a light, porous, granulated slag is obtained without crystallization and powdering. In crystallized slag, olivenes, melilites, amphiboles, pyroxenes, wollastonite, and pseudowollastonite have been found. Slags are used as (1) raw material introduced into the Portland cement furnace, (2) slag cement, formed after granulation, grinding, and the addition of slaked lime, (3) metallurgical cements, obtained after granulation and grinding with Portland cement clinker, and (4) an inert ingredient of concrete. The industrial process of granulation is described. Granulated slag (basic) must be free from crystals, because crystallization diminishes hydraulic properties. Acid slag is used as raw material for Portland cement or as a light addition for concrete. In Portland cement clinker, slag replaces clay. Slag cements are obtained by grinding granulated slag, hydraulic or fat slaked lime, and, usually, alkaline sulfate for catalytic action. Metallurgical cements frequently contain clinker of granulated slag and lime with the addition of gypsum. Compared with Portland cement, iron cement contains less lime and more silica and alumina; it is used almost entirely for sea works and foundations protected from air. It resists fire better and is less expensive than Portland cement but is not so reliable because the composition of slag may vary. The hydration of metallurgical cement is more complex than that of Portland cement and occurs in two separate stages. The clinker grains react as in the case of Portland cement, and calcium hydroxide is liberated, which activates the latent hydraulic properties of granulated slag. The particles of slag darken, and needles and plates of hydrated calcium aluminate and plates of $Ca(OH)_2$ appear, while calcium hydrosilicate remains amorphous (Lea and Desch, *Ceram. Abs.*, **15** [9] 267 (1936)). Supersulfated cements are made of separately ground granulated basic slag 80%, clinker 5%, and anhydrous calcium sulfate 15%. They are resistant to water containing calcium sulfate. M.V.C.

Blast-furnace slags for cement manufacture. R. FERET. *Rev. Matériaux Construction Trav. Publics*, No. 352, pp. 1–4; No. 353, pp. 21–26; No. 354, pp. 41–44; No. 355, pp. 61–65; No. 356, pp. 81–85; No. 357, pp. 101–105 (1939).—F. reviews the knowledge concerning slags. The influence of many factors is uncertain. F. tested a great number of commercial slags of various compositions, using lime, Portland cement, sodium sulfate, and the usual accelerators as additions. Bending and compression strengths are recorded. F.E.V.

Calculation of the chemical composition of the phases of Portland cement on the basis of chemical and microscopical analyses of the clinker. B. TAVASCI. *Tonind.-Ztg.*, **63** [23] 263–65 (1939).—T. shows how to calculate the composition of the phases of cement (or any other product of similiar constitution) if the chemical composition and the proportion of the phases in at least four different clinkers are known. The composition of the clinkers should vary as much as possible. W.K.

Dehydration of raw gypsum at different temperatures; its significance for cement properties. G. MUSSGNUG. *Zement*, **28** [22] 339–44; [23] 355–56 (1939).—The dehydration of raw gypsum begins at 100°C under usual conditions. The degree of dehydration depends on temperature, partial pressure of steam, and, to a large extent, on grain-size conditions. In the critical temperature range (for the cement industry) of 90° to 110°C, the evolution of water is rather erratic for different gypsum specimens. Examples show that cement properties are seriously affected by the hydration of gypsum. F.E.V.

Determination of soluble silica and alumina in Portland cement. T. MIZUNO AND B. MATSUMURA. *Jour. Soc. Chem. Ind. Japan* (Supp. Binding), **41** [12] 438B (1938).—Caution should be used in the analysis of cement. Various methods were examined, and experimental data are compared. More exact methods than that proposed by the Technical Association of Portland Cement in Japan are suggested. M.T.

Portland cements unaffected by excess of water. S. SOLACOLU ET AL. *Zement*, **28** [13] 186–94 (1939).—Cements with a silicate content of 2.0 to 2.1 and an alumina content of 2.0 show good resistivity to excess water. Calcium and aluminum chlorides increase this stability. Rumanian cements used for oil pits contain such electrolytes. F.E.V.

PATENTS

Manufacturing cement and alkali metal aluminate starting with material containing Al_2O_3 and silicic acid. I. G. FARBENIND. A.-G. Fr. 849,039, Jan. 17, 1939. D.A.B.

Production of colored cements. P. GERIMONT. Fr. 825,759, Aug. 19, 1937. D.A.B.

Enamel

Application and use of the Irwin consistometer in enamel slip control. L. J. FROST AND J. F. HUNT. *Jour. Amer. Ceram. Soc.*, **22** [11] 359–63 (1939).

Cleaning and degreasing metal surfaces in the enamel industry. BESEMANN. *Beizerei* (in *Emailwaren-Ind.*, **16** [27–28]), **4** [7] 25–28 (1939).—Methods of cleaning and degreasing metal to be enameled are reviewed. Burning off the grease is being abandoned for the safer, easier, and cheaper method of using the aqueous alkaline solutions which are equally effective (100%). Special products for degreasing are Siliron KZ for baths and Siliron K2 for spraying. When alkali solutions are used for degreasing, the pickling process need not be so intensive as when the grease is burned off because of the absence of ash on the surface of the metal. M.V.C.

Determining the physical properties of enamels. VIELHABER. *Emailwaren-Ind.*, **16** [31–32] 205–206 (1939).—When enamel is fused to metal it assumes a structure entirely different from that of the enamel alone; the enamel layer is permeated with small bubbles which change many properties of enamels, such as the thermal conductivity; this varies with the size and number of bubbles which in turn are dependent principally upon the grinding fineness of the enamel. The expansion due to heat of iron which has been enameled is less than that of the iron alone before enameling but greater than that of the enamel alone; this is also explained by the presence of the small bubbles. It is obvious, therefore, that tests on the heat expansion, elasticity, resistance to pressure, etc., of enamels must be made on enameled ware instead of on the enamel alone. Besides the grain size, other factors, such as the duration of firing, may influence the formation of bubbles in enamels. The control of the size of bubbles is possible by microscopic study. M.V.C

Effects of humidity and composition on strength and Young's modulus of enamels. DWIGHT G. MOORE AND WILLIAM N. HARRISON. *Jour. Research Nat. Bur. Standards*, **23** [3] 329–43 (1939); R.P. 1239. Price 5¢.—Young's modulus and the modulus of rupture of eight types of enamel frit were determined under constant conditions of temperature and humidity by transverse loading of annealed fibers about $^3/_4$ mm. in diameter. One enamel fired on metal specimens was also tested under varying conditions of humidity for resistance to chipping in torsion. Fibers of two of the frits were tested in air under different humidities at constant temperature, immersed in different liquids at constant temperature, and immersed in water-free kerosene at different temperatures. The following conclusions are given: (1) The modulus of rupture of enamel-frit fibers increases with decreasing atmospheric humidity. The maximum change observed was in the sustained-load test, in which a "soft" sheet-iron ground-coat frit was 53% stronger at 56% relative humidity than at 90%, the temperature being 36°C. Under the same con-

ditions an acid-resisting sheet-iron frit was 15% stronger at the lower humidity. (2) In the increasing-load test, the gains in strength of these frits were 8% and 22%, respectively, when the relative humidity was decreased from 98% to 35% at 21°C. (3) The modulus of rupture of enamel-frit fibers was substantially greater when they were dried over $CaCl_2$ and immersed in water-free kerosene than when they were immersed in water, the acid-resisting frit showing a 49% increase and the ground coat a 30% increase. (4) Specimens stored in air at about 60 to 65% humidity and tested while immersed in alcohol and similarly stored specimens tested in air had about equal strengths. (5) Specimens dried over $CaCl_2$ and immersed in kerosene did not vary significantly in strength when the temperature was raised from 27° to 62°C. (6) The moduli of rupture of frit fibers of the sheet-iron cover coats were significantly greater than those of the sheet-iron ground coats and the cast-iron frits when tested by the increasing-load test. The leadless cast-iron frit was significantly weaker than any of the other compositions tested. (7) The modulus of elasticity of two frits was significantly affected by changes in atmospheric humidity. (8) The acid-resisting sheet-iron cover coat and the "hard" sheet-iron ground-coat frit under the test conditions had the highest Young's modulus, approximately 8400 kg./mm.^{2}. The other sheet-iron cover coats and the leadless cast-iron enamel gave average moduli of about 8000 kg./mm.^{2}, while the lead-bearing cast-iron enamels were significantly lower, the high-lead composition being the lowest. (9) The resistance to chipping in torsion of an acid-resisting enamel applied to 20-gauge metal increased about 15% with a decrease in relative humidity from 98% to 35%. A thin paraffin coating over the enamel surface, applied before the specimens were quite cool after firing, increased the resistance of these specimens to chipping by about 30%. R.A.H.

Effects of sodium nitrite in cover enamels. L. A. LANGE. *Bull. Amer. Ceram. Soc.*, **18** [10] 360–63 (1939).

Enameled chemical equipment. ANDREW I. ANDREWS. *Chem. & Met. Eng.*, **46** [7] 406–10 (1939).—In manufacturing enameled equipment, particular consideration should be given to its design, as the facility of the enameling process affects the cost, the type of enamel which may be used, and the perfection of the finished product. A. describes the procedure generally used in manufacturing enameled equipment. Of the tests used for examining the finished ware, special mention is made of the voltage test for detecting "weak spots" or spots where a large bubble underlies the surface, the iodine test for locating cracks, and the salt sponge test for detecting holes in the enamel. In repairing damaged spots in the enamel, sponge gold may be tamped in the hole after it is drilled out clean and tapered slightly to provide an anchorage for the gold. This method is satisfactory for holes up to $^5/_{16}$ in. in diameter. B.C.R.

Fish scaling in ground-coat enamels. J. KLÄRDING. *Stahl & Eisen*, **59**, 268–71 (1939).—Fish scales originate at defective places in the enamel caused by the release of stress. The fish scales can be small or large depressions or even fissures. The types are illustrated. Fish scaling may occur weeks or months after firing. Continued firing at enameling temperature produces small and usually numerous fish scales. The quality of the steel, whether cold- or hot-rolled, has little influence on the shape and size of the fish scales, but adjustment of enamel and steel compositions is not necessarily without influence on the shape of fish scales; adherence is not so good on cold-rolled steel, which has a smooth surface. The viscosities of eight ground-coat enamels were measured by Endell's method. The higher the SiO_2 to alkali oxide ratio, the higher is the viscosity in a system containing these only; in a system of many components, e.g., an enamel, the results show the same tendency. A comparison of the viscosities of the enamels leads to the conclusion that fish scaling is produced where the viscosity is high but not where it is low, because gases formed in firing can escape only in the latter case. An unequivocal relationship does not exist. L.R.B.

Hairlines. W. A. DERINGER. *Bull. Amer. Ceram. Soc.*, **18** [10] 354–56 (1939).

Increasing enamel-shop productivity. ANON. *Ceram. Ind.*, **33** [4] 49–51 (1939).—Installation of a continuous enamel furnace and water-wash reclaiming chambers at the George D. Roper Corp. resulted in a 325% increase in productivity of labor. The continuous furnace uses 8600 cu. ft. of gas per hr., with a production of 11,000 sq. ft. of ground-coat ware and 15,000 sq. ft. of cover-coat ware per day. It replaces four box furnaces using a total of 14,400 cu. ft. of gas daily in producing 7000 sq. ft. of linings and 9000 sq. ft. of cover-coat ware. The continuous unit, therefore, decreases gas consumption 40% and increases production 50%. With the former layout, the following workers were needed in the enamel shop: 24 burners, 12 truckers, 42 brushers, and 10 sprayers. With the new layout only 9 burners, 2 truckers, 14 brushers, and 4 sprayers are required. A total of 284 workers including supervision has been reduced by the new system to 100 workers. See "Double—," *Ceram. Abs.*, **18** [11] 291 (1939). L.M.C.

Inhibitors in steel pickling. C. P. WEISE. *Bull. Amer. Ceram. Soc.*, **18** [10] 356–58 (1939).

Laboratory and shop performance of nonreboiling enameling sheets. J. C. ECKEL. *Bull. Amer. Ceram. Soc.*, **18** [10] 358–60 (1939).

Lead-free enamel for pipe resistors. I. DOROSHEV. *Novosti Tekhniki*, **6** [20] 23–24 (1937); abstracted in *Chem. Zentr.*, **1939, I,** 5025.—Attempts to produce a lead-free enamel for tubular electric resistors are discussed. The enamel batch is composed of 18.9 feldspar, 31.2 boric acid, 14.4 zinc white, 5.65 calcined soda, 1.20 clay, 6.3 fluorspar, 5.0 manganese ore, 1.5 cobalt oxide, and 0.5% chromium oxide. It is fired at 850° in an electric kiln, pulverized, and sifted. M.V.C.

Old enamels with low borax content. VIELHABER. *Emailwaren-Ind.*, **16** [29–30] 189–90 (1939).—Experiments made in Germany to lower the cost of enamels by reducing the borax content showed that in most cases more borax is used in enamels than is necessary. A minimum of 10% boric acid, however, is necessary for sheet-metal ground enamels and 6 to 7% boric acid for sheet-metal white enamels. It is more difficult to reduce the borax content in ground enamels because it serves other purposes than that of flux. Batches with low borax content are tabulated. M.V.C.

Porosity of technical enamels. LUDWIG STUCKERT. *Sprechsaal*, **72** [35] 453–54 (1939).—The chief cause of the corrosion of technical enamels is their faulty chemical constitution, but disintegration is often brought about by the slow penetration of liquids (water and acids) through the enamel by means of capillary canals, cracks, pores, and open bubbles. The testing of enamels for the absence of pores and other openings, therefore, becomes, with the solubility test, the most important control in the manufacture of acidproof enamels for cast iron. S. found that a ground enamel free from pores cannot be obtained, but coating enamels (white, gray, or other color) may be produced which are entirely free from pores and which will protect the ground coat from corrosion. The presence of pores may be determined by the electrolytic process of Anglucci, slightly changed by the Laboratory for Clay Industry ("Formation—," *Ceram. Abs.*, **13** [2] 43 (1934)). S. describes the electrolytic process and modifications and gives illustrations showing iron deposits around the pores and other holes in the surface of the enameled ware tested. M.V.C.

Preliminary study of wetting agents in ground-coat enamels. D. J. BENOLIEL. *Bull. Amer. Ceram. Soc.*, **18** [10] 353–54 (1939).

Production methods in modern enameling plant. ANON *Ceram. Ind.*, **29** [3] 186–92 (1937).—The Sunbeam Electric Mfg. Co., Evansville, Ind., uses an open-flame gas drier in the pickle room, and the waste heat from the radiant-tube furnace helps to heat the tunnel drier. The furnace used is approximately 60 ft. long, has a hot zone 21 ft. long, and is of the counterflow type, heated by seven gas-fired radiant-tube heating elements. Illustrated. E.J.V.

Status of enameling of steel and cast iron. L. VIELHABER. *Stahl & Eisen*, **59**, 8–12 (1939).—The principles and technology of enameling on iron and steel are examined. Metallographic structure, surface texture, and the limits of chemical composition of the metal stock for satisfactory adherence are discussed from the standpoint of enamel texture. The importance of the thermal expansion of the metal and enamel is emphasized. Metal degreasing and cleaning, typical compositions of ground and cover coats, sources of raw materials, firing technique in muffle and continuous furnaces, and the use of charging machines are dealt with. Enamel defects and their causes and the range of application of enameled products are also discussed. L.R.B.

SEPARATE PUBLICATIONS

Enamel Storage. H. G. WOLFRAM. *Enamelers' Reference*, No. 2, 7 pp. Porcelain Enamel & Mfg. Co., Baltimore, 1939.—W. suggests the use of water from the mill room for the temperature control of enamel storage. Illustrated. F.G.H.

Sanitary Cast-Iron Enameled Ware. *Nat. Bur. Standards Com. Standards*, CS77-39, 6 pp. Free.—This standard is effective for new production beginning with October 10, 1939. The purpose is to establish minimum standard specifications, definitions, inspection rules, and methods of test for sanitary cast-iron enameled ware for the guidance of manufacturers, distributors, and users of this product. The standard covers material of the base, thickness, enameling, warpage, flaws, blemishes, and acid resistance of the ware as well as labeling and trademarks. R.A.H.

PATENTS

Ceramic ware wall structure. B. J. SWEO. U. S. 2,177,046, Oct. 24, 1939 (March 5, 1937).—A unitary pyrometer tube comprises concentric tubular layers of semivitreous porcelain resistant to high temperatures and an intermediate layer therebetween composed of vitreous porcelain which is impervious to gases so that it constitutes a seal for the pores in the semivitreous porcelain, all of the layers being intimately bonded together by firing them as a unit.

Enameled mesh base electrode. J. L. GALLUP (Radio Corp. of America). U. S. 2,175,689, Oct. 10, 1939 (Dec. 10, 1936).—A mosaic electrode includes an enameled perforated base comprising a nickel base having apertures and a vitrified enamel coating completely covering the base to provide apertures having enameled walls, the enamel consisting of an alkali-lime glass base containing from 8% to 15% boric anhydride and melting at about 900°C and having an electrical resistivity of about 1×10^{13} ohm centimeters, and metallic plugs containing silver fitted into the apertures.

Enameling metallic articles. I. G. FARBENIND. A.-G. Brit. 513,451, Oct. 25, 1939 (April 22, 1937).

Improving glazes and enamels. DEUTSCHE TAFELGLAS A.-G. Fr. 49,676, Aug. 17, 1938; addition to 797,295 (*Ceram. Abs.*, **16** [11] 359 (1937)). D.A.B.

Producing enamel, particularly white clouded iron enamel. I. KREIDL. Brit. 512,476, Sept. 27, 1939 (March 4, 1937).

Removing enamel. MAX ZIMMERMANN AND WERNER FUNKE (I. G. Farbenind. A.-G.). U. S. 2,174,454, Sept. 26, 1939 (April 2, 1936).—A process for removing enamel from enameled articles comprises subjecting the enameled articles to the action of an aqueous solution of a mixture of hydrofluoric acid and sulfuric acid at a temperature of 20° to 30°C, the acids being present in about equal proportions.

Glass

Anglo-Dutch stem glasses. WILFRED BUCKLEY. *Arts & Dec.*, **50** [5] 10, 11, 36 (1939).—The Anglo-Dutch drinking glasses are made of lead glass. The bowls are slightly concave, and the stems are light balusters with one or more knops toward the top, one of which at least contains air bubbles more or less elongated and occasionally lengthened into threads. The feet are plain and never folded. Illustrated. L.F.M.

Artificially formed surface layers on glass. ANTONIN VAŠIČEK. *Kolloid-Z.*, **86**, 288–95 (1939).—The results of measurements of the refractive index obtained by the polarimetric method and by the method of smallest diffraction on prisms of various new and 20 year old glasses (after fresh polishing) are presented. Two tables show the results of studies of surface layers made artificially by the chemical action of 1.0 *N* NaOH and H_2SO_4 solutions. The latter forms a thin surface upon the glass layer which protects the glass against the acids. NaOH does not form such a layer; solutions of alkali (NaOH), therefore, cause corrosion of the glass. Tests have shown that NaOH dissolves the surface layer of glass, the action being faster on a crown glass prism than on flint glass. Quartz glass which was exposed for 4 hr. to solutions of NaOH and H_2SO_4 showed no change in the surface. Proof of the presence of surface layers upon the glass is given by the interference phenomena of light. The thickness of the surface layer upon the flint glass, calculated from the interference color, was approximately 2×10^{-4} mm. L.E.T.

Change in electrical conductivity of glass during devitrification. I. SAWAI AND A. WADA. *Jour. Soc. Chem. Ind. Japan*, **41** [11] 717–19 (1938); in Supp. Binding, pp. 355–56B.—When the glass is heated and the devitrification occurs it is interesting to note how the electrical conductivity will change with the growth of crystals. Soda-silicate glass of the composition $Na_2O \cdot 2SiO_2$ was studied. Samples were prepared, and the annealing and devitrifying temperatures for them were determined. At 580°C, the glass devitrifies and the electrical resistance increases ten times after 20 min. The surface conductance caused by the moisture in the air was avoided by measuring the moisture at 160° and 200°C. As the heating time is altered up to 16 hr., resulting in the various degrees of devitrification, the curves of log ρ (electrical resistance) $- t$ (time) indicate that the longer the glass is heated, the more the resistance increases; after about 4 hr., the curves change their directions and crystals are visible. The mean energy of replacement from one position to the other for Na^+ was calculated by applying the formula devised by Preston and Seddon. M.T.

Check on the aging process in glassy bodies by magnetic measurements. G. F. HÜTTIG AND E. STROTZER. *Z. Anorg. & Allgem. Chem.*, **236** [1–4] 107–20 (1938).—To follow the aging process in glasses by measurements of the magnetic susceptibility, cobalt was added to plate glass, and a cobalt borate in the glassy state was made up. The glasses were used in powder form, and the tests were run at various but constant temperatures. The curves show an initial minimum and then a maximum and finally flatten out. The borate shows no minimum. The heat of reaction was calculated from the figures obtained. W.K.

Controlling glass bottle design and quality. ANON. *Ceram. Ind.*, **33** [5] 33–35 (1939).—At the Whitall-Tatum Glass Division of the Armstrong Cork Co., a special design and specification department is maintained to suggest safe bottle designs to customers and to guide them toward bottle designs that can be manufactured without undue difficulties. This department also sets up working details for production and prepares a set of specifications to be followed. A comprehensive bottle-testing procedure is followed. For liquor and catsup bottles, polariscope tests are made every 2 hr. on a bottle from each mold in use. An internal-pressure test is made on Preston's machine, and this is followed by a thermal-shock test with 90° differential. One bottle is taken from each lehr every 2 hr. and subjected to ring-section examination under the polarizing microscope. The ABC rating method suggested by the Glass Container Assn. is used, with plus and minus variations for finer grading. A new continuous acid etching machine is used for frosting gin bottles. With a minimum of labor, the machine handles up to 15 gross per hour

of fifths. Rubber suction cups protect the neck ring and the customer's blown-in trademark from the acid solution. L.M.C.

Corrosive action of opal glass on fusing pots. EGON ARNOT. *Sprechsaal*, **72** [33] 425–27 (1939).—The corrosive action of opal glass on pots is caused by the presence of fluorine and sulfur salt grains and iron particles which settle on the bottom of the pot before the batch is completely fused. The large grains of fluorine cause the greatest corrosion because they melt more slowly; this may be remedied by sifting out the large grains in the raw material. Since the greatest corrosion is on the pot floor, it should be made thicker than that of pots for ordinary batches, and before the batch is introduced, a layer of pure broken opal glass should be fused on the pot floor to form a protective coat. No pot mix exists which is entirely resistant to the action of fluorine salts, but resistance increases with increasing alumina content. Fired kaolin is the most suitable material, but it has the disadvantage of being too thick. A basic mix is more resistant. M.V.C.

Department of Glass Technology, University of Sheffield, England. ANON. *Bull. Amer. Ceram. Soc.*, **18** [11] 442–43 (1939).

Drawing sheet glass without debiteuse. A. N. GERMANOV. *Keram. & Steklo*, **14** [1] 6 (1938); *Verre & Silicates Ind.*, **9** [20] 232–34 (1938).—A method of drawing glass without waving was devised and perfected sufficiently for industrial application. The dimensions of the drawing tank and "screen" are given. The composition of the glass was modified for work at high temperatures and approaches that used for the Gregorius process in America: SiO_2 71.8, CaO 8.5, MgO 2.99, and Na_2O 15.2%. The process of formation of the strip of glass depends greatly on the thermal régime, but the submersion of the drawing bar is even more important; the best depth for the bar is 70 mm. The formation of the glass strip in this process differs from that in the Fourcault process. M.V.C.

Effect of alumina on devitrification of soda-lime-silica glasses. W. B. SILVERMAN. *Jour. Amer. Ceram. Soc.*, **22** [11] 378–84 (1939).

Geometrical form of glass containers, especially bottles. G. STEINKE. *Glashütte*, **69** [9] 148–53 (1939).—S. discusses the form of a glass body in dependence on its use. The form and the type of curve of the transition piece between neck and body are the determining characteristics of a bottle. Diagrams show that the principal contour curves consist of simple conic sections. The geometrical curve of the transition piece between neck and body of a large number of bottles was studied and was found to be either an arc of a circle, an ellipse, a parabola, a hyperbola, a combination of two of these curves, conic sections of a higher order, or other curves. In practice, the knowledge of the exact geometrical curves of bottles helps in the detection of defects, errors in calculation, or variation in volume and in computing the strength of the form. M.V.C.

Glass in decoration. ANON. *Verre & Silicates Ind.*, **10** [17] 194–95 (1939).—The application of blown opal glass to mural decorative panels and frescoes according to the Verropal process eliminates the difficulties and high cost of executing frescoes in tile mosaic. The simplified method of placing the tile, which are assembled in panels at the workshop, is shown. The novel treatment of Thermolux glass for decorative windows is illustrated. M.V.C.

Glass milk bottles. ANON. *Milk Ind.*, July, 1939; reprinted in *Glass*, **16** [8] 321 (1939).—The advantages of glass bottles over paper containers for use in the milk industry are discussed. B.C.R.

Glass storage tanks for electric hot-water heaters. FRITZ GLOTH. *Glastech. Ber.*, **17** [7] 215–17 (1939). J.F.H.

Glassworks of Smaland Woods. PHILIP GUSTAFSON. *Arts & Dec.*, **50** [3] 16, 17, 47 (1939).—Orrefors (named after waterfalls and birds in Smaland) glass is so fluid and transparent that its crystal shapes seem about to melt into the air around them. Only the best importation of white sand is used for the crystal glass. Subjects pertaining to the sea, birds, and falls are used in engraving these heavy modern forms of glass. Illustrated. L.F.M.

High-temperature viscosities of soda-silica glasses. H. R. LILLIE. *Jour. Amer. Ceram. Soc.*, **22** [11] 367–74 (1939).

Improved glass tank design. ANON. *Ceram. Ind.*, **33** [4] 42–48 (1939).—A new tank at the Carr-Lowrey Glass Co. has two doghouses, equipped with automatic feeders timed opposite in phase, to allow the raw batch to be spread over a wider area, thus decreasing channeling and preventing accumulations of stagnant glass near the end wall and side walls. The metal depth in the working end is only 18 in., and the working-end bottom is well insulated. These innovations give uniform temperature in the glass in the working end so that movement toward the machines is a depth movement and not merely on the surface. The bridge wall has two openings instead of the usual one, to prevent accumulations of stagnant glass in the corners of the nose end. L.M.C.

Lusterware. JEANETTE R. HOGDON. *Arts & Dec.*, **51** [1] 12, 13, 34 (1939).—A luster surface on small objects is produced by painting or stenciling a design on glazed pottery with a metallic salt and firing. The sheen is protected by an overglaze. Luster objects can be produced in silver, platinum, pink, blue, yellow, gold, etc. Illustrated. L.F.M.

Making visible the temperature distribution in glass furnaces. F. DREXLER AND W. SCHÜTZ. *Glastech. Ber.*, **17** [7] 205–207 (1939).—A series of colored powders called Thermocolor has been developed by I. G. Farbenind. A.-G.; they possess the property of changing color at definite temperatures. When they are applied to a heated refractory surface, the various temperature zones become visible. They should be useful in studying temperature distribution in molds and as warnings against overheating. See "Temperature-indicating—," p 22. J.F.H.

Molecular refraction in glasses. W. GEFFCKEN. *Glastech. Ber.*, **17** [8] 237–40 (1939).—The additivity of constant refraction increments as developed by Biltz *et al.* is of practical use in the field of technically important glasses, but the dependence of the increments on concentration as emphasized by Kordes ("Physicochemical—," this issue, p. 10) must be considered in presenting total refraction curves. Biltz *et al.* failed to consider properly the work of Wulff and Majumdar (*Z. Physik. Chem.*, **B31,** 319–42 (1936)) on B_2O_3-Na_2O glasses where definite departure from additivity was shown. The similarity in behavior of aqueous solutions and glasses is strongly emphasized. G. prefers the use of partial molal quantities in presenting such data instead of the methods of Biltz and Kordes. An example of the use of partial molal quantities is given in detail, using the data of Wulff and Majumdar for the system B_2O_3–Na_2O. J.F.H.

Optical methods of examination in the glass industry. HANS FREYTAG. *Umschau*, **43** [24] 568–70 (1939).—F. describes two methods of detecting tension and other faulty spots in glass. Light is polarized by reflecting it on a dark reflecting surface. It passes through the object and is watched with polarized spectacles. Tension is indicated by color changes. Other results may be revealed either by filling glass vessels with liquids of the same refractory exponent as that of the glass or by placing the piece of glass in the liquid. Normal light is passed through glass and liquid. J.M.N.

Optical silvering on glass. B. DASANNACHARYA AND A. C. SETH. *Phil. Mag.*, **26** [179] 953–70 (1938).—The Martin-Brashear process was employed, and the effect of the concentration of the mixtures, cleanliness of the surface, optimum temperature, and excess of the reagents on the efficiency of silvering was studied. The most satisfactory cleaning procedure consisted in rubbing the glass surface with cotton and soap, dipping it into chromic acid, and washing with tap water and distilled water. An excess of silver nitrate added to the ammoniacal $AgNO_3$ and KOH solution prior to mixing with the reducing solution caused spots in the mirror, while excess ammonia reduced the

rate of silver deposited as mirror. The optimum temperature was 20°C. The quantity of silver deposited as mirror was a function of the amount of surface presented per gram of $AgNO_3$, rather than the concentration of the silver nitrate, best results being obtained with a concentration of 525 sq. cm. per g. of $AgNO_3$. R.H.

Over 5000 different pieces produced at glassware plant. ANON. *Ceram. Ind.*, **29** [3] 193–94 (1937).—Fifteen to twenty thousand pieces a day of blown and pressed glassware are manufactured by the Inland Glass Co., Chicago, Ill. Over 5000 different pieces are in regular production. A semiautomatic mixing operation is carried out in a large rotary mixer. Two continuous furnaces and nine day tanks are used for melting the glass, while three gas-fired mechanical lehrs are used for annealing, the time for which is dependent upon the type of ware being run. A decorating lehr is used for firing on color. Illustrated. E.J.V.

Photochemistry of glass and its practical importance. HANS FREYTAG. *Umschau*, **42** [46] 1060–63 (1938).—F. describes how the chemical blending of glasses makes them highly transparent for defined wave length and enables them to absorb certain defined ranges. Means for producing glass for X-ray purposes and other related uses are given. Bibliography. J.M.N.

Physicochemical investigation of the fine structure of glasses: II. ERNST KORDES. *Z. Physik. Chem.*, **B43**, 119–52 (1939).—K. discusses glass systems (SiO_2–Na_2O, $NaAlSi_3O_8$–$CaAl_2Si_2O_8$, P_2O_5–PbO, $MgSiO_3$–$CaSiO_3$, B_2O_3–Na_2O, and SiO_2–PbO) for which the mole fractions of exclusively constant reaction increments of the participating atoms may be calculated. These exceptions may be predicted on the basis of their particular structure and their particular polarization effects. The molar volume of binary acid silicates and phosphate glasses may be calculated under consideration of their structure with the aid of the molar volume of pure SiO_2-respectively pure P_2O_5 glasses and the ionic radii of the total volume of the participating atoms. In the system P_2O_5–PbO, this is possible to approximately 90 mol. % PbO. In this system it was also possible to calculate the refraction of light for measured PbO glasses (up to 61 mol. %) in good agreement with observed values. The crystallized genuine orthosilicates differ, in regard to mole fractions, distinctly from the pseudo-orthosilicates, e.g., Be_2SiO_4 and Zn_2SiO_4. Six diagrams. For Part I see "Relation—," *Ceram. Abs.*, **18** [8] 207 (1939). L.E.T.

Progress report on the activities of A.S.T.M. Committee C-14 on glass and glass products. LOUIS NAVIAS, *Secretary*. *Bull. Amer. Ceram. Soc.*, **18** [11] 433 (1939).

Properties of glasses containing titanium and cobalt oxide. I. SAWAI AND K. SUDA. *Jour. Soc. Chem. Ind. Japan*, **41** [11] 719–20 (1938); in Supp. Binding, p. 356B. The influence of TiO_2 on the physical and chemical properties of Na_2O-CaO-SiO_2 glass containing cobalt oxide (SiO_2 71.82, Al_2O_3 0.92, CaO 4.61, Co_3O_4 5.98, Na_2O (difference) 16.67%) appears to change according to the constituents of the basic glass. The expansion coefficient rises with increase of TiO_2 and the effect is greater above the transformation temperature. Replacement of SiO_2 by TiO_2 seems to increase hardness. In agreement with Dietzel (*Cer. m. Abs.*, **17** [6] 212 (1938)), addition of TiO_2 greatly increases the acid-resisting qualities of glass but decreases alkali resistance. M.T.

Relieving the pressure of production in a glass bottle plant. ANON. *Ceram. Ind.*, **29** [4] 262–67 (1937).—The Latchford Glass Co., Los Angeles, Calif., uses three continuous tanks of the end port regenerative type. A unique underground cooling system is used in connection with the bottle machines which eliminates much of the confusion of overhead piping. Spare feeder parts are kept hot in a special furnace, so that no time is lost when replacements are necessary. Illustrated. E.J.V.

Safety glass. V. E. YARSLEY. *Times Trade & Eng.*, **45** [906] 42 (1939).—The two chief producers of safety glass in England, the Lancegaye Safety Glass (1934), Ltd., and the Triplex Safety Glass Co., have amalgamated. Triplex safety glass, made under the original Benedictus patents, was the pioneer in this field. In addition to the laminated or sandwich glass, both companies manufacture toughened glass, a material which does not use a reinforcing plastic layer. The manufacture and manipulation of transparent plastic sheet for aircraft, etc., has been brought to a remarkable state of perfection. A.B.S.

Significance of radiation chemistry and its procedures for the science and technology of glass. HANS FREYTAG. *Glastech. Ber.*, **17** [8] 240–47 (1939). J.F.H.

Stone defects in glass. L. v. PUTNOKY AND N. v. BOBEST. *Sprechsaal*, **72** [31] 402–403 (1939).—A direct method is described which permits the stone lumps in the glass to be separated from the glass by reason of the difference in their specific gravities (at least 0.05). The separation is made as follows: A mixture of acetylene tetrabromide (Muthmanns liquid, specific gravity 2.97 to 3.00) and xylene (specific gravity 0.862) is used for separating. The acetylene tetrabromide is easily thinned with xylene so that any specific gravity between 0.862 and 3.00 can be obtained. A stone as large as possible and with the least possible glass particles adhering to it is selected from the faulty glass and finely powdered in an agate mortar. The acetylene tetrabromide is placed in a 50 cc. shaking cylinder, and the powdered stone and several small grains of pure glass about 1 mm. in diameter are poured in. The cylinder is shaken vigorously, and xylene is dropped from a burette until the stone grains and glass grains begin to separate, the stone grains sinking slowly to the bottom of the cylinder and the glass grains pushing to the surface of the liquid. More xylene is dropped in and mixed with the liquid by shaking until the separation of the two types of grains increases in rapidity and sharpness, i.e., until the specific gravity of the liquid approaches the mathematical mean value of the specific gravity of the two kinds of grains. The liquid is transferred in a separating funnel and left to stand until separation and sedimentation are complete. The liquid is filtered off and can be used again. A microscopic examination will show whether any glass grains remain in the deposited sediment; if this is the case, the sediment must be ground finer in the agate mortar and again separated. After the second separation, results are usually satisfactory. The sediment is washed first with benzine and then with ether. It can then be analyzed. M.V.C.

Structure of broken surfaces and the breaking process in glasses. ERNST REXER. *Glastech. Ber.*, **17** [7] 207–15 (1939).—Breaks caused by tension and by detonation were examined microscopically. Besides the well-characterized mirrored, roughened, and furrowed zones, a fine structure is also superimposed. This is characterized by tufts and a wavy appearance caused by groups of curves, which are connected with the presence of coarse flaws and are therefore not always observable. Their course depends on tension distribution and indicates the direction of maximum strain changes during breaking. **Criticism.** ADOLF SMEKAL. *Ibid.*, [8] 250–51.—Priority in the discovery of some of the fine structure described by Rexer in connection with tension breaks is claimed for other workers. J.F.H.

Structure of silica and potassium silicate glasses. G. HARTLEIF. *Z. Anorg. & Allgem. Chem.*, **238** [4] 353–84 (1938).—Silica glass and potassium silicate glasses containing 15, 25, and 35% K_2O were investigated with the ionometric X-ray method. The apparatus is described in detail. The potassium glasses contain two independent constituents: a silica glass and a potassium-bearing part, possibly a disilicate or a metasilicate. The degree of order increases with increasing K_2O content, but it is not probable that a crystallized phase exists. Observed variations may be due to the history of the glass. W.K.

Studies of purple hues of glass continue for six decades. ANON. *Bull. Amer. Ceram. Soc.*, **18** [10] 403 (1939).

Surface irregularity of "twin" plate glass. ANON. *Glass*, **16** [5] 193 (1939).—In a new procedure for finishing plate glass, the glass is ground on both sides simultaneously and then polished on both sides. Compared with the usual method of grinding and polishing first on one side and then on the other, the new procedure appreciably

decreases the amount of surface variation, thereby reducing distortion to a minimum. B.C.R.

Three years in the building and development of a designing room in the glass industry. WILHELM WAGENFELD. *Glastech. Ber.*, **17** [8] 247–50 (1939). J.F.H.

Use of the electric metal spray gun in glass technology. M. U. SCHOOP. *Glastech. Ber.*, **17** [7] 217–18 (1939).—A small arc fuses the metal which is then atomized by compressed air. Glass wool was made using a Schoop gun. Enamels, glass, and quartz coatings have also been made successfully with the use of an acetylene flame. J.F.H.

Vanadium as a glass colorant. W. A. WEYL, A. G. PINCUS, AND A. E. BADGER. *Jour. Amer. Ceram. Soc.*, **22** [11] 374–77 (1939).

BOOK

Glass Factory Year Book and Directory. American Glass Review, Pittsburgh, 1939. 160 pp. Price $5.—Complete data on all manufacturers of glass products in the U. S. and Canada are given. Classifications of glass products, indexes of raw materials, equipment, and finished products, and some statistical and technical information are included. F. G. HECK

PATENTS

Apparatus for:

Feeding glass furnaces. COMPAGNIE DES LAMPES. Fr. 841,244, July 27, 1938. D.A.B.

Forming glass sheets. AMERICAN WINDOW GLASS CO. Brit. 513,186, Oct. 18, 1939 (May 10, 1938). Brit. 513,189, Oct. 18, 1939 (May 19, 1938). Brit. 513,200, Oct. 18, 1939 (May 4, 1938); divided out of 513,190 (this issue, p. 13).

Manufacturing objects in glass. KENT-OWENS MACHINE CO. Fr. 828,082, Oct. 20, 1937. D.A.B.

Producing a cloth of glass fibers. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 831,684, Dec. 24, 1937. D.A.B.

Producing ground and polished glass strip. PILKINGTON BROS., LTD., F. B. WALDRON, AND J. H. GRIFFIN. Brit. 512,159, Sept. 20, 1939 (March 31, 1938). F. B. WALDRON AND F. E. SLOCOMBE (Pilkington Bros., Ltd.). U. S. 2,176,480, Oct. 17, 1939 (March 4, 1938). U. S. 2,176,481, Oct. 17, 1939 (March 4, 1938; renewed Aug. 10, 1939).

Apparatus and process for:

Continual winding of glass threads, etc. COMPAGNIES RÉUNIES DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Fr. 848,966, July 21, 1938. D.A.B.

Distributing molten glass. HARTFORD-EMPIRE CO. Fr. 840,113, June 30, 1938. D.A.B.

Manufacturing bottles. LYNCH CORP. Fr. 831,541, Dec. 31, 1937. D.A.B.

Manufacturing glass fibers. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 825,755, Aug. 19, 1937. D.A.B.

Manufacturing glass tubes. P. L. RAIMBAULT. Fr. 48,810, Feb. 19, 1937; addition to 814,038. D.A.B.

Manufacturing threads, bands, etc., from glass fibers. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 829,394, Nov. 17, 1937. Fr. 49,686, Aug. 25, 1938; addition to 829,394. D.A.B.

Preparing silica for glass charges. CORNING GLASS WORKS. Fr. 48,995, Dec. 3, 1937; addition to 805,111 (*Ceram. Abs.*, **16** [11] 339 (1937)). D.A.B.

Producing glass thread, etc. N. V. MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Fr. 48,737, Aug. 21, 1937; addition to 726,355, Nov. 18, 1931. D.A.B.

Producing glass thread and objects therefrom. SCHLESISCHE SPIEGELGLAS MANUFACTUR C. TIELSCH G.M.B.H. Fr. 827,220, Sept. 29, 1937. D.A.B.

Tempering glass. AMERICAN SECURIT CO. Fr. 839,264, June 14, 1938. R. E. MONNIER. Fr. 48,924, April 17, 1937; addition to 829,348, Feb. 18, 1937. D.A.B.

Tempering glass sheets. NEUE GLASINDUSTRIE G.M.B.H. Fr. 840,374, Dec. 31, 1937. D.A.B.

Application of glass fibers to materials coming into contact with liquids, e.g., wicks. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 833,541, June 16, 1937. D.A.B.

Article marking or decorating apparatus. DAVID DENELSBECK (Owens-Illinois Glass Co.). Can. 383,721 and 383,722, Aug. 29, 1939 (Oct. 12, 1937). G.M.H.

Automatic machine for beveling glass. LOUIS GUGALA. U. S. 2,174,721, Oct. 3, 1939 (April 2, 1938).

Bands, ribbons, wicks, etc., in glass fibers. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 833,304, Feb. 5, 1938. D.A.B.

Blown hollow glass objects joined to a part of solid glass. W. DUDEK. Fr. 833,991, Feb. 18, 1938. D.A.B.

Casehardening glass sheets. L. V. BLACK (Pittsburgh Plate Glass Co.). U. S. 2,174,254, Sept. 26, 1939 (March 13, 1937).

Casseroles, etc. BRITISH HEAT RESISTING GLASS CO., LTD., AND D. G. HANN. Brit. 511,634, Sept. 8, 1939 (May 30, 1938).

Colored glass. F. J. DOBROVOLNY, J. M. YOUEL, AND H. E. KLEIN (E. I. du Pont de Nemours & Co.). U. S. 2,174,554, Oct. 3, 1939 (Dec. 15, 1937).—A method for preparing ruby glass comprises preparing a glass melt which contains a copper compound and a metallic cyanogen compound selected from the group consisting of metal cyanides, cyanates, and cyanamides.

Continuous production of multilayer glass. NEUE GLASINDUSTRIE G.M.B.H. Fr. 840,466, July 8, 1938. D.A.B.

Cracking-off machine. A. B. KNIGHT. U. S. 2,177,807, Oct. 31, 1939 (Jan. 28, 1937).

Decorating vitreous surfaces. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 840,936, Jan. 7, 1938. D.A.B.

Double-walled electric lamps. SOC. ANON. POUR LES APPLICATIONS DE L'ÉLECTRICITÉ ET DES GAZ RARES ÉTABLISSEMENTS C. PAZ & SILVA. Brit. 512,803, Oct. 11, 1939 (Jan. 28, 1938).

Double-walled glass containers and method of producing. H. K. KIMBLE. Brit. 511,626, Sept. 8, 1939 (May 10, 1938).

Drawing glass on table or in continuous sheet. DEUTSCHE TAFELGLAS A.-G. Fr. 834,193, Feb. 24, 1938. D.A.B.

Electrically heated blower. GAMES SLAYTER (Owens-Corning Fiberglas Corp.). U. S. 2,175,224, Oct. 10, 1939 (Oct. 4, 1934; renewed Dec. 19, 1938).

Electric furnaces for melting or fining glass. E. V. BOREL AND SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Brit. 513,581, Nov. 1, 1939 (Feb. 14, 1938).

Electric heating and flow control of molten glass. L. D. SOUBIER (Owens-Illinois Glass Co.). U. S. 2,179,224, Nov. 7, 1939 (May 18, 1937).

Electric insulators. CORNING GLASS WORKS. Brit. 513,379, Oct. 25, 1939 (Sept. 7, 1937).

Fiber glass-containing plastic. CARLETON ELLIS (Ellis-Foster Co.). U. S. 2,176,837, Oct. 17, 1939 (Dec. 14, 1936).—A laminated glass containing at least two panes of light-transmitting glass is bonded together by a composite light-transmitting glass-resinous material composition, the resinous composition having substantially the same index of refraction as the glass.

* **Fused multifocal ophthalmic lens and blank for making.** J. H. HAMMON. U. S. 2,177,021, Oct. 24, 1939 (May 7, 1937). U. S. 2,177,022, Oct. 24, 1939 (May 7, 1937; Dec. 31, 1937).

Fused silica article manufacture. R. D. SMITH (Corning Glass Works). Can. 383,078, Aug. 1, 1939 (Nov. 22, 1937; in U. S. Dec. 11, 1936). G.M.H.

Gas-filled incandescent electric lamps. Soc. Anon. pour les Applications de l'Électricité et des Gaz Rares Établissements C. Paz & Silva. Brit. 512,791, Oct. 11, 1939 (Jan. 27, 1938).

Glass-article manufacture. States Lee Lebby (Corning Glass Works). Can. 383,232, Aug. 8, 1939 (Feb. 1, 1938; in U. S., Feb. 5, 1937). G.M.H.

Glass-batch feeder. C. A. Brown and C. W. Craig (General Electric Co.). U. S. 2,178,418, Oct. 31, 1939 (July 28, 1937).

Glass-cleaning fluid. Earl D. Norton (Carbide & Carbon Chemicals, Ltd.). Can. 383,826, Sept. 5, 1939 (June 22, 1936). G.M.H.

Glass feeding and severing mechanism. F. L. O. Wadsworth (Ball Bros. Co.). U. S. 2,174,905, Oct. 3, 1939 (March 18, 1933; Dec. 18, 1936).

Glass furnace and method of operation. S. A. Forter (Forter-Teichmann Co.). U. S. 2,179,848, Nov. 14, 1939 (Feb. 17, 1939).

Glass-furnace paddle. Heraclio Alfaro. Can. 383,-161, Aug. 8, 1939 (Aug. 3, 1937). G.M.H.

Glass-grinding apparatus. Pilkington Bros., Ltd. Fr. 832,989, Jan. 31, 1938. D.A.B.

Glass-grinding tool. J. H. Griffin (Pilkington Bros., Ltd.). U. S. 2,179,740, Nov. 14, 1939 (Sept. 2, 1938).

Glass-to-metal seal. J. E. Beggs (General Electric Co.). U. S. 2,174,374, Sept. 26, 1939 (Sept. 15, 1934; renewed April 22, 1939). U. S. 2,174,375, Sept. 26, 1939 (Sept. 15, 1934; March 20, 1937). T. A. Elder (General Electric Co.). U. S. 2,174,381, Sept. 26, 1939 (Oct. 4, 1934).

Glass-polishing apparatus. Pilkington Bros., Ltd., F. B. Waldron, and J. H. Griffin. Brit. 512,336, Sept. 20, 1939 (March 24, 1938). F. B. Waldron and J. H. Griffin (Pilkington Bros., Ltd.). U. S. 2,178,504, Oct. 31, 1939 (March 23, 1939).

Glass treatment. A. J. Miller. Fr. 828,013, Oct. 18, 1937. D.A.B.

Glass vessel. W. W. Shaver and H. K. Martin (Corning Glass Works). U. S. 2,177,336, Oct. 24, 1939 (July 1, 1935).—A glass vessel has its surface layers under compression and an inner tension zone, the maximum degree of tension of which does not exceed 2.6 kg. per mm.^{2}.

Glassworking apparatus. L. D. Soubier (Owens-Illinois Glass Co.). Can. 383,723, Aug. 29, 1939 (Dec. 29, 1937). G.M.H.

Grinding glass. U. Gottesmann. Fr. 832,648, Jan. 26, 1938. D.A.B.

Hermetic seals between metal and vitreous material. Siemens Electric Lamps & Supplies, Ltd., J. N. Aldington, and A. J. Meadowcroft. Brit. 512,974, Oct. 11, 1939 (April 22, 1938).

Hollow glass articles. Owens-Illinois Glass Co. Fr. 825,524, Aug. 12, 1937. D.A.B.

Hollow glass body making apparatus. H. H. Blau (Corning Glass Works). Can. 383,235, Aug. 8, 1939 (Aug. 23, 1938; in U. S. Sept. 16, 1937). Raymond W. Kell (Corning Glass Works). Can. 383,236, Aug. 8, 1939 (Aug. 30, 1938). G.M.H.

Insulated glass containers having double walls void of air. Firma Carl Mittelbach & Co. Fr. 833,780, Feb. 15, 1938. D.A.B.

Insulating glass. Soc. Anon. des Manufactures des Glaces & Produits Chimiques de St. Gobain, Chauny & Cirey. Fr. 839,431, March 12, 1938. D.A.B.

Insulating and weather-resistant materials. Games Slayter (Owens-Corning Fiberglas Corp.). U. S. 2,175,-226, Oct. 10, 1939 (Dec. 30, 1936).

Interlayer for safety glass and method of making. H. R. Marini (Pittsburgh Plate Glass Co.). U. S. 2,176,997, Oct. 24, 1939 (July 28, 1936).

Laminated safety glass. Carl J. Malm (Canadian Kodak Co., Ltd.). Can. 383,682, Aug. 29, 1939 (April 21, 1937; in U. S. May 16, 1936). G.M.H.

Lehr feeder. N. R. Beck (Carr-Lowrey Glass Co.). U. S. 2,176,241, Oct. 17, 1939 (June 10, 1938).

Lehr gas desulfurization. R. D. Smith (Corning Glass Works). Can. 383,233, Aug. 8, 1939 (March 15, 1938; in U. S. April 26, 1937). G.M.H.

Lens. F. E. Altman (Eastman Kodak Co.). U. S. 2,176,482, Oct. 17, 1939 (Nov. 6, 1937).

Lens-abrading machine. L. W. Goddu and C. H. Caldwell (American Optical Co.). U. S. 2,179,088, Nov. 7, 1939 (May 13, 1935).

Light-directing brick and walls and buildings utilizing them. T. W. Rolph (Holophane Co., Inc.). U. S. 2,179,-863, Nov. 14, 1939 (Aug. 25, 1933).

Light polarizer. E. H. Land and H. G. Rogers (Polaroid Corp.). U. S. 2,173,304, Sept. 19, 1939 (May 4, 1939).—A transparent sheet which polarizes light by differential absorption of transmitted components comprises oriented, long, chain molecules of an organic plastic, some of which are dichroic and some of which are negligibly dichroic, the dichroic molecules being the product of an alteration within the sheet of the molecular structure of negligibly dichroic molecules and consisting essentially only of atoms of elements present in the negligibly dichroic molecules.

Machine for grinding the edges of plates such as lenses. A. T. Jordan and P. Lever. Brit. 512,104, Sept. 20, 1939 (Nov. 30, 1938).

Machine for transforming glass tubes. J. Dichter. Fr. 49,609, June 30, 1938; addition to 800,160. D.A.B.

Making a coated glass sheet. A. D. Nash (Pittsburgh Plate Glass Co.). U. S. 2,177,000, Oct. 24, 1939 (July 17, 1936).

Making glass wool. Games Slayter (Owens-Corning Fiberglas Corp.). U. S. 2,175,225, Oct. 10, 1939 (Oct. 11, 1934; renewed Nov. 4, 1937).

Manufacture of glass. F. L. Koethen and I. J. Wernert (E. I. du Pont de Nemours & Co.). U. S. 2,174,517, Oct. 3, 1939 (July 21, 1938).—In a glassmaking process, a step comprises introducing into the glass melt an inorganic cyanogen compound selected from the group consisting of the metal cyanides, cyanates, and cyanamides.

Manufacture of glass. Vereinigte Glühlampen und Elektrizitäts A.-G. Brit. 512,292, Sept. 20, 1939 (Oct. 2, 1937).

Manufacture of reinforced glass. Soc. des Usines Chimiques Rhône-Poulenc. Brit. 511,996, Sept. 8, 1939 (May 4, 1937).

Manufacture of vitreous silica and other refractory vitreous siliceous materials. General Electric Co., Ltd., and J. H. Partridge. Brit. 512,622, Oct. 4, 1939 (March 7, 1938).

Manufacturing armored glass. Soc. Anon. des Manufactures des Glaces & Produits Chimiques de St. Gobain, Chauny & Cirey. Fr. 49,102, June 1, 1937; addition to 828,824 ("Reinforced—," *Ceram. Abs.*, **18** [5] 127 (1939)). D.A.B.

Manufacturing construction elements in glass. Corning Glass Works. Fr. 49,023, Dec. 9, 1937; addition to 789,963. D.A.B.

Manufacturing glass articles having precised optical surfaces. Corning Glass Works. Fr. 832,810, Jan. 31, 1938. D.A.B.

Manufacturing glass fibers in the form of twisted thread or filament. Soc. Anon. des Manufactures des Glaces & Produits Chimiques de St. Gobain, Chauny & Cirey. Fr. 827,026, Sept. 22, 1937. D.A.B.

Manufacturing quartz or hard glass bases for lamps. Vereinigte Glühlampen und Elektrizitäts A.-G. Fr. 839,211, June 13, 1938. D.A.B.

Mechanical treatment of glass ampoules. C. Poure et Fils. Fr. 831,322, April 6, 1937. D.A.B.

Method and apparatus for:

Coating vitreous tubes. W. M. Clark and C. D. Spencer (General Electric Co.). U. S. 2,178,419, Oct. 31, 1939 (Dec. 11, 1936).

Feeding molten glass. K. E. Peiler (Hartford-Empire Co.). U. S. 2,175,407, Oct. 10, 1939 (Aug. 11, 1936).

Forming glass building blocks. R. H. Barnard. U. S. 2,179,317, Nov. 7, 1939 (July 10, 1936).

Forming glass sheets. AMERICAN WINDOW GLASS CO. Brit. 513,187, Oct. 18, 1939 (April 29, 1938). Brit. 513,188 and 513,190, Oct. 18, 1939 (May 4, 1938).

Producing hollow glass articles. L. D. SOUBIER (Owens-Illinois Glass Co.). U. S. 2,174,930, Oct. 3, 1939 (Feb. 1, 1937).

Producing sheet glass or plates. A. E. SPINASSE. U. S. 2,173,345, Sept. 19, 1939 (Nov. 30, 1931).

Method and means for making contact lenses. WILLIAM FEINBLOOM. U. S. 2,178,873, Nov. 7, 1939 (June 26, 1936; renewed Dec. 3, 1937).

Mold-operating mechanism for glassware-forming machines. FRANK O'NEILL (Hartford-Empire Co.). U. S. 2,175,064, Oct. 3, 1939 (Aug. 30, 1935; April 22, 1937).

Multifocal lens and method of making. H. W. HILL (American Optical Co.). U. S. 2,173,651, Sept. 19, 1939 (Jan. 21, 1937).

Nonrefillable bottle. T. F. KOLTS (Warren Buckley). U. S. 2,179,510, Nov. 14, 1939 (April 2, 1937).

Nonrefillable bottle closure. T. F. KOLTS (Warren Buckley). U. S. 2,179,511, Nov. 14, 1939 (Oct. 28, 1937).

Objects in crystal or tempered glass. E. VESENTINI. Fr. 834,061, Feb. 21, 1938. D.A.B.

Ophthalmic lens. A. E. GLANCY AND L. L. GAGNON (American Optical Co.). U. S. 2,180,003, Nov. 14, 1939 (March 12, 1937).

Ornamental glass. AL SELSKY. U. S. 2,174,899, Oct. 3, 1939 (Aug. 13, 1938).

Percolator. JOSEPH MASIN. U. S. 2,175,440, Oct. 10, 1939 (Nov. 12, 1938).

Perforated plate for the manufacture of glass fibers, etc. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 840,-237, July 5, 1938. D.A.B.

Perfume bottles. VERRERIES POCHET ET DU COURVAL. Fr. 829,087, Nov. 15, 1937. D.A.B.

Pot furnace for melting glass heated by hearth automatically fed from underneath. STEIN ET ROUBAIX (SOC. ANON.). Fr. 840,686, July 15, 1938. D.A.B.

Process and apparatus for bending glass sheets. R. A. MILLER (Pittsburgh Plate Glass Co.). U. S. 2,176,999, Oct. 24, 1939 (April 27, 1937).

Process and apparatus for tempering tubular glass articles. PILKINGTON BROS., LTD. Brit. 512,976, Oct. 11, 1939 (March 22, 1938).

Production of coiled vitreous tubing. THEODOR PFAFF (General Electric Co.). U. S. 2,177,743, Oct. 31, 1939 (June 9, 1936).—A process of producing vitreous tubing in the form of a coil, etc., comprises gathering a parison of glass between a blowpipe and a gathering iron, drawing a length of tubing of the desired dimension from the parison, and bending it into the desired form while it is still plastic.

Production of spun glass. F. POLLAK AND F. NEUMANN. Brit. 511,857, Sept. 8, 1939 (Feb. 24, 1938).

Recovering residual material produced by the fine grinding and polishing of glass. N. S. GARBISCH. Fr. 833,-677, Feb. 11, 1938. D.A.B.

Reflecting brick and walls and buildings utilizing them. T. W. ROLPH (Holophane Co., Inc.). U. S. 2,179,862, Nov. 14, 1939 (Aug. 25, 1933).

Reflecting device. C. A. PERSONS (Persons-Majestic Mfg. Co.). U. S. 2,180,093, Nov. 14, 1939 (March 10, 1936).—A reflector comprises a glass plate designed to be used in an inclined position and provided with a plurality of units, each unit comprising a convex lens on one side of the plate and a convex projection (coated to perform the functions of a mirror) on the opposite side of the plate, the mirror being located in reflecting relationship to the lens and offset upwardly with reference to the lens, the mirror of each unit extending above its respective lens and laterally beyond it at opposite sides thereof for substantial distances, but the lens extending below the lower edge of the mirror, the lower edge of each mirror being connected to the plate by a surface extending from the edge and meeting the plate on a line closely adjacent the upper edge of the mirror of the unit next below and above the lower portion of its related lens, the lens and mirror being arranged substantially in autocollimating relation on an axis at an acute angle to the plate.

Sealed hollow glass article forming apparatus. H. H. BLAU (Corning Glass Works). Can. 383,234, Aug. 8, 1939 (Aug. 23, 1938; in U. S. Sept. 8, 1937). G.M.H.

Separators and diaphrams made of glass thread for electric accumulators, etc. COMPAGNIES RÉUNIES DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Fr. 832,939 and 832,940, May 28, 1937. D.A.B.

Sheet-glass manufacture. F. L. BISHOP AND L. P. FORMAN (American Window Glass Co.). Can. 383,802, Sept. 5, 1939 (June 24, 1938; in U. S. May 19, 1938). ALBERT J. BUNDY (American Window Glass Co.). Can. 383,803, Sept. 5, 1939 (June 24, 1938; in U. S. May 4, 1938). PETE MAGRINI (American Window Glass Co.). Can. 383,804, Sept. 5, 1939 (June 24, 1938; in U. S. May 4, 1938). HARRISON DEAN MENOHER (American Window Glass Co.). Can. 383,805, Sept. 5, 1939 (June 24, 1938; in U. S. May 10, 1938). G.M.H.

Surface treating glass containers. O. G. BURCH (Owens-Illinois Glass Co.). U. S. 2,175,076, Oct. 3, 1939 (Sept. 25, 1936; renewed Feb. 25, 1939).

Tempered glass article and method of making. BERNARD LONG (American Securit Co.). U. S. 2,177,324, Oct. 24, 1939 (March 29, 1937).—A method to divide a tempered glass article into several pieces consists in producing along the periphery of each piece to be obtained a band in which the glass is untempered and causing the fragmentation of the glass in the zones of tempered glass outside these pieces.

Tempering glass. G. E. HOWARD (Hartford-Empire Co.). U. S. 2,178,520, Oct. 31, 1939 (July 1, 1936).

Tempering glass objects. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Fr. 839,667, June 23, 1938. D.A.B.

Tempering glass sheets. R. E. MONNIER. Fr. 829,-198, Feb. 12, 1937. D.A.B.

Tongs for handling glassware. F. W. DUHAN (Crown Cork & Seal Co., Inc.). U. S. 2,176,251, Oct. 17, 1939 (Sept. 15, 1937).

Tubing blank making apparatus. W. H. SAID (Corning Glass Works). Can. 383,077, Aug. 1, 1939 (Oct. 14, 1937; in U. S. Nov. 23, 1936). G.M.H.

Vitreous sealing substance. D. V. EDWARDS (Electrons, Inc.). U. S. 2,175,019, Oct. 3, 1939 (Dec. 19, 1935; Sept. 16, 1936).—Means for sealing two pieces of metal comprises a glass seal adapted to adhere to both of the pieces, the glass having a composition which can be identified as having approximately the molecular proportions Na_2O 20, SiO_2 60, and FeO 20, whereby the glass is highly elastic and tough so that after being melted to form the seal it does not rupture upon cooling.

Structural Clay Products

Coefficients of heat transmission from building materials. S. P. CLEMENTSON. *Heating & Ventilating Engr.*, **11** [127] 338 (1938).—A convenient method for calculating the heat-transmission coefficients of building materials (brick, concrete, asbestos, etc.) consists in using a specially constructed slide rule which gives the coefficients of conductivity of the material over a wide range of thicknesses. R.H.

Heat-loss coefficients. L. J. OVERTON. *Heating & Ventilating Engr.*, **11** [130] 493 (1938).—O. summarizes values of heat conductivity obtained by various investigators for window glass, plate glass, two panes of glass close together, skylights, pavement lights, building brick, diatomaceous brick, terra cotta, sandstone, marble, limestone, and concrete. R.H.

Increase in the strength of brickwork by the use of scored brick. A. Poganv. *Tonind.-Ztg.*, **61** [79] 879–80 (1937).—The strength of brickwork increases if the brick have grooves about 3 mm. deep and 20 mm. apart. W.K.

Precast tile beam floor. Henry Giese and C. T. Bridgman. *Bull. Amer. Ceram. Soc.*, **18** [10] 371–73 (1939).

Protection for brick buildings. Walther Marschner. *Umschau*, **41** [52] 1193–94 (1937).—Soluble sulfates in the raw materials of brick result in corrosion and discoloration. An addition of barium carbonate reacts with the sulfates to produce insoluble barium sulfate and protects the building against destruction. See "Technique—," *Ceram. Abs.*, **16** [1] 50 (1937); "Determination—," *ibid.*, **18** [10] 269 (1939). J.M.N.

Setting brick in a continuous kiln. E. Kurzer. *Tonind.-Ztg.*, **62** [102] 1138–40 (1938).—K. describes the best methods of setting brick under varying conditions and for special results. Illustrated. W.K.

Solution of an unusual brick manufacturing problem. Frank E. Lobaugh and Harold C. Harrison. *Bull. Amer. Ceram. Soc.*, **18** [10] 375–76 (1939).

Testing brick cement walls. Kristen. *Umschau*, **41** [40] 915–17 (1937).—K. describes tests made with actual fire on walls under heavy load built from different kinds of brick. J.M.N.

PATENTS

Brick. Josef Scheibl (Juliana Orbell). U. S. 2,176,805, Oct. 17, 1939 (May 13, 1937).—A building brick has a centrally disposed horizontal opening throughout its length, a plurality of parallel side openings on each side of the horizontal opening, and spaced, vertically disposed notches in its end walls, into which mortar is adapted to be poured to form a joint between adjacent brick ends in a wall, the notches connecting with the side openings only.

Building. P. J. Stockman. U. S. 2,174,394, Sept. 26, 1939 (Sept. 16, 1938).—A method of constructing walls, etc., from brick.

Interlocking brick wall. W. C. Fuller (A. W. Richey and William Heian). U. S. 2,173,104, Sept. 19, 1939 (Aug. 23, 1937).

Treatment of porous surfaces (stone) and compositions therefor. G. King and A. R. Warnes. Brit. 513,366, Oct. 25, 1939 (March 5, 1938).

Refractories

Advances in refractory materials in 1938. C. R. Platzmann. *Tonind.-Ztg.*, **63** [22] 256–57; [23] 266–68; [26] 310–11; [29–30] 348–50; [34] 395–96 (1939). W.K.

Basic linings for high-frequency induction furnaces. Anon. *Brit. Steelmaker*, **5**, 180 (1939).—The following properties are essential for linings used with high-frequency electric furnaces: basicity, volume stability, and maximum density. The hitherto universal practice of using graded magnesite is not satisfactory, due to the permanent contraction of the latter. The combination of magnesite with alumina, forming spinels, provides much greater control of volume stability; this is assisted by molding the linings under pressures up to 20,000 lb. per sq. in. Such linings more than double the length of service obtained with a magnesite lining. R.H.

Basic refractories. J. H. Chesters. *Jour. West Scot. Iron & Steel Inst.*, **46** [4] 65 (1938–39).—C. outlines recent developments in the field of chrome-magnesite, magnesite, and dolomite brick. Chrome-magnesite brick for use in open-hearth furnaces should possess high thermal shock resistance and low bursting tendency in the presence of iron oxide. These properties can be obtained by control of grading, chrome-magnesite ratio, and additions. The properties of eight brands of chrome-magnesite brick are given. Magnesite brick, if used in exposed positions in open-hearth furnaces, generally fail due to structural spalling. The precise cause of this spalling is not clear but in all probability is due to the shrinkage which occurs when slag enters the hot face of the brick. Magnesite brick of high bulk density and high initial thermal shock resistance should therefore give better results. Encouraging results have been obtained on brick made from magnesite derived from dolomite and sea water. Properties of eleven well-known brands of magnesite brick are summarized. The conditions that must be met in producing a satisfactory dolomite brick for use in the hearths of basic open-hearth furnaces are discussed. Satisfactory dolomite brick can be made by the addition of a siliceous material such as magnesium silicate together with a stabilizer. See *Ceram. Abs.*, **17** [11] 355 (1938); *Jour. Amer. Ceram. Soc.*, **22** [4] 97–104 (1939). B.C.R.

Budapest firebrick works. E. Loewinger. *Brit. Clayworker*, **48** [568] 168–70 (1939).—A short description of the manufacture of aluminous brick is presented. R.A.H.

Design of glass-tank blocks. Harold Shaw. *Glass*, **16** [8] 329 (1939).—As a manufacturer of glass-tank blocks, S. believes further research work should be carried out to develop a smaller sized block, such as one weighing about 50 to 100 lb., made with a tongue and groove. The use of such a block would permit quicker delivery and lower prices. At present, profits are low due to the high breakage resulting from flaws in tamping or casting and breakage in transportation and in the kiln. B.C.R.

Development of high-frequency furnaces. L. Dreyfus. *Tek. Tid.*, **69C** [2] 1–4 (1939).—D. describes electric furnaces developed by the Swedish General Electric Co. He refers to the simultaneous application of a polyphase low-frequency current, which sets up a stirring action, and a single-phase high-frequency current for melting. He describes the method of preparing the refractory acid lining and quotes an example in which such a lining in a $4^1/_2$-ton furnace lasted for 400 heats before it had to be completely renewed. Sintered magnesite is satisfactory as a basic lining only in furnaces of up to 2 tons, because on reaching a temperature of 1600°C a crystalline transformation occurs which causes the material to contract. A suitable basic material has already been perfected on an experimental scale and is being tried out in a 1600-kg. double-frequency furnace. A small high-frequency furnace designed for the heat treatment of tools is described which is specially suitable for boring bars for mining. R.A.R.

Electric furnaces and their application in the steel industry. O. Inman and H. A. Wainwright. *Brit. Steelmaker*, **5**, 277–82, 317–20, 323–24 (1939).—Various types of resistance heating furnaces are described. The choice of refractory supports for heating elements is determined by the temperature conditions. Up to 800°C, firebrick containing about 45% alumina are satisfactory. For higher temperatures, sillimanite or mullite must be used. Heat-insulating material is generally used for electric resistance furnaces. When the temperature of the outside refractory surface is not higher than 500°C, slag and glass wool provide efficient heat insulation. Between 500° and 800°C diatomaceous material, in the form of brick or densely packed powder, is required. High-frequency induction furnaces and arc furnaces are also dealt with. Heat balances for some of these furnaces show a thermal efficiency of 60 to 65%. R.H.

Forsteritic refractories made from serpentine and magnesite. G. Malquori, V. Sollazzo, and A. Giannone. *Ricerca Sci.*, [2] **9, II** [9–10] 615–19 (1938).—A serpentine containing SiO_2 38.53, Al_2O_3 3.81, Fe_2O_3 6.80, FeO 1.51, CaO trace, MgO 34.30, and undetermined 0.47% (loss on calcination 14.50) was calcined, mixed with the required amount of MgO for the forsteritic transformation and in some cases for the periclase-forsteritic transformation, and finely ground. The mixture was pressed, dried slowly with increasing temperature, and then fired to Seger cone 14 to 15 for 8 to 10 hr. The forsteritic and periclase-forsteritic brick prepared and tested in accordance with the Comitato Termotecnico Italiano's specifications had the following properties: apparent porosity, 27.8 and 28.4%; weight

per volume, 2.25 and 2.27; refractoriness, Seger cone 36 and 37; initial temperature, 1600° and 1590°C; cooling temperature, 1660° and 1600°C; expansion and reduction, 0% and 0%; and average coefficient of expansion between 20° and 950°C, 11.8 × 10^{-6}. V.S.M.

Heat insulation of boiler settings. C. F. WADE. *Steam Engr.*, **8**, 313–14 (1939).—Refractory insulating materials for boiler settings, flues, etc., are advocated for uses already common in the case of kilns. The materials available are classified as diatomaceous and hot-face insulating brick and concrete containing aggregate made of these. For a Lancashire-boiler setting the following suggestions are made for heat insulation. Downtake walls should have 4½ in. of good quality firebrick on the inner face and 4½ in. of hot-face insulating firebrick on the outer face. Paving of boiler flues should be 4½ to 6 in. of insulating concrete superposed on the usual concrete raft (this is justified, if only because it avoids subsidence due to shrinkage of the soil). The sides of boiler flues should have hot-face insulating brick 4½ in. thick on a common-brick backing. L.R.B.

Influence of the crystalline structure of bauxite on its decomposition by the Bayer method. ALBERT ROTH. *Metall & Erz*, **35** [17] 447–50 (1938).—Two crystal forms of bauxite which have identical chemical analyses behave differently when treated by the Bayer method. R. finds that boehmite yields high efficiency while diaspore cannot be used at all. Twenty-three different bauxites from Greece, Hungary, Rumania, Yugoslavia, Italy, France, South America, and India were analyzed, checked for efficiency, and radiographed. The efficiency varies from 1 to 98.5% for similar analyses. The radiographs prove that the existence of the diaspore structure is detrimental to the successful use of the Bayer method. No bauxite with diaspore content yielded more than 70% efficiency. The radiographic method, by finding the diaspore content, saves the cost of expensive tests with an unknown material. J.M.N.

Lining high-frequency furnaces. J. B. STÅLHANE AND V. ANDERSON. *Jernkontorets Ann.*, **123** [7] 386–406 (1939).—After a brief historical review of the development of high-frequency furnaces for steel-making, some of the earlier type linings for small furnaces are described. Quartz and burned magnesite are compared as materials for lining the larger modern furnaces. The possibilities of developing linings of basic materials are dealt with, and curves are presented showing the expansion properties of Zirkit (a material containing 80 to 90% of zirconium oxide), magnesite, spinel, alumina, sillimanite, and zirconia. The authors specify the requirements of a good basic lining in terms agreed upon by themselves in conjunction with L. Dreyfus, L. Högel, and the Swedish General Electric Co. A suitable material called BM mixture (in Swedish, BM-massa) has been produced, which consists mainly of magnesite to which are added certain new synthetic products of Zirkit. This material can be rammed to a density equivalent to 20% porosity, and its contraction on sintering, even after long periods at high temperature, is less than 1%. Its melting point is above 1900°C. Tests of this material in a 32-cwt. electric furnace at Sandviken have given good results, and the lining shows no tendency to crack after 70 charges. See "Development —," p. 14. R.A.R.

Mineralogical composition of calcium aluminate slags and extraction of the alumina. I. N. PROKHNITSKIĬ. *Legkie Metally*, **6** [7–8] 17–19 (1937); abstracted in *Chimie & Industrie*, **41** [1] 83 (1939).—Slags with high alumina content and low silica content (4 to 6%) yield a large amount of extracted alumina. Conversely, pulverulent slags with high lime content and more than 6% silica yield little alumina. Pulverulent slags are characterized by a high $2CaO \cdot SiO_2$ content. Among the aluminates they contain especially $5CaO \cdot 3Al_2O_3$ and $3CaO \cdot Al_2O_3$. This absence of monoaluminate, which has the highest concentration of alumina, lowers the yield in the latter. M.V.C.

Mud gun redesigned. ANON. *Iron Age*, **144** [8] 47 (1939).—Blast-furnace clay guns made by the William M. Bailey Co. embody recent principles of design. The gun is a combination of the screw and piston types, with a pressure of 600 lb. per sq. in. at the nozzle, and is capable of plugging any tapping hole, under full pressure, in 40 to 45 sec. E.H.McC.

Open-hearth slag control. W. J. REAGAN. *Iron Age*, **144** [7] 31–38 (1939).—The fluidity of slag has considerable influence on carbon drop and therefore on the production of basic open-hearth steel. The viscosimeter is the best means of controlling fluidity. The apparatus consists of a funnel (into which molten slag is poured) attached to a tube (in which is measured the distance the slag runs before solidifying). R. discusses the effect of various additions and cites the work of C. H. Herty, Jr. (*Ceram. Abs.*, **15** [11] 336 (1936)). E.H.McC.

Preparation of pure alumina from Manchurian clays: V. TSUYOSHI ARIMORI. *Jour. Soc. Chem. Ind. Japan*, **41** [11] 737–41 (1938); in Supp. Binding, p. 364B.—A. gives the results of investigations on the conditions for the crystallization of pure ammonium alum from the solution obtained by the sulfuric acid-extraction process. This method is devised to separate the pure aluminum compounds as precipitates from solutions containing iron and other impurities, leaving iron in solution. Reagents prepared from chemically pure $Al_2(SO)_4 \cdot 18H_2O$, ferric and ferrous sulfate, and ammonium sulfate were used in various concentrations in this determination of the optimum yield of alumina and the removal efficiency of iron. Favorable conditions are as follows: (1) the concentration of alumina in the solutions before crystallization must be 8% in weight, (2) the ferric sulfate in the solutions must be reduced to the ferrous state before crystallization, (3) the excess equivalent of ammonium sulfate should be added, (4) the ammonium alum should be washed with 20% ammonium sulfate solution at least 3 times. Under these conditions pure ammonium alum of $Fe_2O_3/Al_2O_3 \times 100 = 0.02$ was obtained from the solutions of $Fe_2O_3/Al_2O_3 \times 100 = 5\%$ with an efficiency of recovery as high as 95%. **VI.** *Ibid.*, **42** [1] 52–55 (1939); in Supp. Binding, pp. 33–34B.—To determine the theoretical degree of recovery of pure ammonium alum from aluminum sulfate solutions for application to the treatment of Chinchou aluminous shale (from which it is obtained by the sulfuric acid extraction process), A. measured the solubilities of ammonium alum in ammonium sulfate solutions of various concentrations at different temperatures. The optimum conditions under which ammonium alum can be crystallized with a high efficiency of recovery are as follows: (1) the concentration of aluminum sulfate solution before crystallization must be more than 8% $Al_2O_3(Al_2O_3/H_2O \times 100 = 8\%)$ in weight, (2) the temperature of crystallization should be at least under 20°C, and (3) the amount of ammonium sulfate added should be more than 1.5 times the chemical equivalent. Pure ammonium alum was prepared from Chinchou aluminous shale (ignition loss 14.18, SiO_2 41.05, Al_2O_3 40.75, Fe_2O_3 1.29, and TiO_2 1.82%). Even from the extracted solution having the ratio $Fe_2O_3/Al_2O_3 = 3.09\%$, pure ammonium alum is prepared with a yield efficiency of 96.4% and contains only 0.002% Fe_2O_3 and a trace of other impurities. For Parts **I–IV** see *Ceram. Abs.*, **18** [1] 24 (1939). M.T.

Quality of refractory brick used in the construction of glass-tank furnaces. X. *Argile*, No. 197, pp. 25–27 (1939).—The best results are obtained with nonporous block produced from fused cast materials containing 45 to 70% Al_2O_3. M.V.C.

Rapid test of the resistance of refractories to carbon monoxide. K. PUKALL. *Sprechsaal*, **71** [26] 321–24 (1938).—The destruction of refractory brick by the cleaving action of carbon from CO, resulting from the reaction $2CO \rightleftharpoons CO_2 + C$, was investigated. The apparatus (illustrated) used was an ordinary laboratory furnace and a porcelain tube 45 mm. in diameter and 800 mm. long. The free ends of the tube are cooled by water-cooled lead pipe coiled around them. The outside ends are closed with perforated rubber stoppers, one for the admission of N_2 or CO and the other for the thermoelement and the removal of the $CO\text{-}CO_2$ mixture in the furnace. The tube for the

removal of the hot gases is water-cooled further to protect the rubber stopper. The gas-inlet tube made of sillimanite (like the protective tube of Pythagorasmasse for the thermoelement) was found to be very resistant to the action of CO. In the furnace, the test pieces are attached to the gas-inlet pipe which is shoved inside them a little way and hermetically sealed with cement, e.g., kaolin water glass. The test pieces are 65 mm. long and have an outer diameter of 40 mm.; the diameter of the interior boring, which extends inside the test piece only deep enough to keep the walls and base of equal thickness, is 10 mm. The test pieces are bored wet with a diamond drill, dried, and placed in the furnace. The path of the CO is as follows: from the bomb the CO flows through a washing bottle and then to the gas meter; before it passes through a second washing flask, the gas pressure is measured in a manometer; the CO then reaches the specimen through the sillimanite tube; after passing through the specimen, the CO becomes mixed with CO_2 in the furnace chamber and passes through another gas flask into the air. Not every refractory material can be broken down by the method given; a silicate block with high iron concentration showed no disintegration or carbon deposit. Magnesite samples lasted 18 hr., but very sensitive grog brick were completely destroyed after 15 to 20 min. The problem of increasing resistance to CO attack was also studied. Not the iron content, but rather the surface and combination of the iron for catalytic action are responsible for the destruction. The best remedy is the scorification of the iron at high temperature; by this means, specimens which, in their normal state, were soon destroyed, were rendered completely insensitive to CO after a second firing to 1400°. M.V.C.

Reactions of slag with refractories: II, Refractory coatings produced with metallic aluminum. H. G. SCHURECHT. *Jour. Amer. Ceram. Soc.*, **22** [11] 384–88 (1939); for Part I see *ibid.*, [4] 116–23.

Refractories from limestone and dolomite. REINHART. *Tonind.-Ztg.*, **63** [2] 15–16; [3] 29–30 (1939).—R. discusses recent patents for the manufacture of refractory materials whose main constituents are silicates of calcium and magnesium. W.K.

Refractory linings of boilers. RUDOLF RASCH. *Wärme*, **62** [13] 221–24 (1939).—R. gives detailed information for the designer of boilers on construction, attack of slag on the refractory and its prevention, and the design of joints between different parts of the lining. See "Use—," *Ceram. Abs.*, **18** [8] 215 (1939). J.M.N.

Refractory material for the iron industry. I. SJÖSTRÖM. *Jernkontorets Ann.*, **123** [4] 165–90 (1939).—In a review of the properties and applications of modern refractory materials used in the iron and steel industry, particularly those used in Sweden, S. deals with the subject under the following headings: (1) fireclay brick, (2) basic brick, (3) silica brick, (4) plastic lining materials, (5) stoppers, and (6) spouts. His information is based largely on the results of laboratory and full-scale work at the Höganäs steelworks. He refers to the improvements which have resulted from firing firebrick in tunnel furnaces (improving the uniformity of the quality) and to the dry-pressing process which reduces the porosity. During the last few years a silica brick has been manufactured in Sweden from Swedish raw materials which is taking the place of German and British silica brick in Scandinavia. Its analysis is silica 96.4, alumina 0.8, ferric oxide 0.7, lime 2.0, and magnesium oxide 0.1%; the softening point is about 1680°C. Sweden imports all of her basic brick; magnesite of suitable quality occurs in Lapland, but there are no transport facilities to bring it to the industrial districts. A new method of making both magnesite and chrome-magnesite brick without firing but with a chemical binder has been developed; the brick are pressed under extremely high pressure (up to 1000 atm.), with the result that the dimensions of the finished brick are extremely accurate. When these brick are first brought up to temperature, the chemical binders become weaker between 900° and 1000°C; at a slightly higher temperature the components of the brick sinter, and, when a temperature of 1300°C is reached, the brick regains its original strength. At steel-making temperatures, therefore, these brick behave as well as brick fired in the manufacturing process, and experience shows that they can be used in the walls of open-hearth furnaces. These brick, however, cannot always be re-used after a furnace has been repaired. R.A.R.

Shaping by vibration as a method for improving the properties of silica brick for coke ovens. G. V. KUKOLEV AND A. T. ZELENSKAYA. *Koks & Khim.*, **7** [12] 30–36 (1937); abstracted in *Chem. Zentr.*, **1939, I,** 5026.—A brief description of the apparatus used is given. It is possible to manufacture high-grade brick. M.V.C.

Silicon carbide tube recuperators. ANON. *Engineering*, **148** [3844] 319 (1939).—The construction of a recuperator using tubes of silicon carbide is described and illustrated. These tubes are made in standard lengths of 4 ft. 4 in.; they are $5^3/_4$ in. in diameter and have inside a core of fire clay to increase the internal convection area and heat transfer. In this installation, 105 tubes were used. A special cement is applied at the ends to make gastight joints. In addition to having a much greater thermal conductivity than fire-clay materials, silicon carbide is less permeable to gases, more resistant to spalling, and more inert to furnace gases. B.C.R.

Sources and uses of refractory materials in the metallurgical industry. C. C. DOWNIE. *Mining Jour.* [London], **203** [Nov. 19] 1053–54; [Nov. 26] 1095–96 (1938).—D. reviews the applications of magnesite, dolomite, bauxite, chromite, kieselguhr, sillimanite, graphite, vermiculite, and kyanite. See "Vermiculite—," p. 28. A.G.S.

Surface heat losses. J. G. COUTANT. *Iron Age*, **143** [12] 42–46 (1939).—Heat lost from furnaces may vary 50% depending on whether emission is from the roof, the side wall, or the bottom. A loss of 20% may be traced to the kind of paint on any part of the furnace, and a 20% variation may be dependent on the proximity of damp earthen floors and the location of water shields. C. discusses aluminum-foil insulation, thermal paints, and thin insulated walls and gives several examples based on his accompanying table of heat loss with wall temperatures of 101° to 700°C. E.H.McC.

Treatment of fused product composed chiefly of calcium aluminate with alkaline solution: I. KEI-ICHI AKIYAMA. *Jour. Soc. Chem. Ind. Japan*, **41** [11] 776–78 (1938); in Supp. Binding, pp. 376–77B.—A. studied the treatment of fused products composed chiefly of Ca aluminate with alkaline solution to determine the favorable conditions for extracting pure alumina from various calcium aluminate slags, certain relations for the solubility of alumina, and the hydraulic properties as well as the compositions of slags. The process thus found for the extraction of pure alumina was applied to diaspore clay, crude bauxite, high aluminous clay, and aluminum phosphate. A. deals with the fused product C-6 ($5CaO \cdot 3Al_2O_3$) (*ibid.*, p. 10; in Supp. Binding, p. 5B) with solutions of sodium carbonate. With this solution containing more than 3 equivalent amounts of Na_2O/Al_2O_3 molar ratio, $5CaO \cdot 3Al_2O_3$ is completely (100%) decomposed, and the solutions of sodium aluminate ($NaAlO_2$) can be prepared. **II.** *Ibid.*, **42** [1] 6–9 (1939); in Supp. Binding, pp. 8–9B.—The extraction of alumina from four kinds of calcium aluminate ($3CaO \cdot 5Al_2O_3$, $CaO \cdot Al_2O_3$, $5CaO \cdot 3Al_2O_3$, and $3CaO \cdot Al_2O_3$) was tried through treatment with alkaline solution. Fused slags (containing high aluminous and low calcareous substances as well as silica) were obtained by synthesis. The solutions used were sodium carbonate, sodium carbonate (90% of total Na_2O) and sodium hydroxide (10% of total Na_2O), and sodium carbonate (75% of total Na_2O) and sodium hydroxide (25% of total Na_2O). The results are as follows: (1) $3CaO \cdot 5Al_2O_3$ and $CaO \cdot Al_2O_3$ are decomposed by Na_2CO_3 containing NaOH solution, and the alumina is almost completely extracted: $3CaO \cdot 5Al_2O_3 + 3Na_2CO_3 + 4NaOH = 3CaCO_3 + 10NaAlO_2 + 2H_2O$; $CaO \cdot Al_2O_3 + Na_2CO_3 = CaCO_3 + 2NaAlO_2$. The reaction of $CaO \cdot Al_2O_3$ needs NaOH for complete decomposition. (2) $5CaO \cdot 3Al_2O_3$ will be completely decomposed with sodium carbonate solution only: $5CaO \cdot$

$3Al_2O_3 + 5Na_2CO_3 + 2H_2O = 5CaCO_3 + 6NaAlO_2 + 4NaOH$. (3) The complete extraction of alumina from $3CaO \cdot Al_2O_3$ was difficult probably because of its rapid hydration. (4) The fused substance containing more alumina than that equivalent to the formula $3CaO \cdot 5Al_2O_3$ is extracted incompletely; the insoluble alumina is excessive. (5) the extraction of alumina from the fused high aluminous products consisting of 25 to 30% CaO and small amounts of SiO_2 decreases as SiO_2 content increases. In these cases, Na_2CO_3 solution only is not effective; with a mixed solution of NaOH (25% as Na_2O) and Na_2CO_3 a maximum extraction is obtained. If the content of SiO_2 is less than 5% the extraction efficiency reaches more than 90%. M.T.

Water-resisting dolomite brick; their uses in war times. Felix Singer. *Brit. Clayworker*, **48** [567] 115–20 (1939). —S. discusses dolomitic deposits in England, the production of sintered dolomite and brick, the production of water-resisting sintered dolomite and dolomite brick, and the properties and uses of such brick. R.A.H.

PATENTS

Apparatus for heat-treating furnace linings. W. E. Moore and W. B. Wallis (Pittsburgh Research Corp.). U. S. 2,174,927, Oct. 3, 1939 (Sept. 9, 1938).

Checkerwork. Henry Tanner (Chicago Retort and Fire Brick Co.). U. S. 2,176,157, Oct. 17, 1939 (Dec. 7, 1938).

Checkerwork structure. A. G. McKee. U. S. 2,179,-666, Nov. 14, 1939 (Aug. 5, 1938).

Coke oven with internally heated movable heating walls. Franz Puening. U. S. 2,174,832, Oct. 3, 1939 (Sept. 5, 1936).

Coke oven with movable heating walls. Franz Puening. U. S. 2,174,833, Oct. 3, 1939 (Nov. 11, 1936).

Composition comprising silicon carbide. W. J. Tennant (Carborundum Co.). Brit. 513,265, Oct. 18, 1939 (March 7, 1938).

Decomposition of alunite. F. K. Cameron, E. O. Huffman, and J. A. Taylor. U. S. 2,174,684, Oct. 3, 1939 (Sept. 9, 1936).

Furnace floor. J. H. Lawrence (Metropolitan Engineering Co.). U. S. 2,173,690, Sept. 19, 1939 (Feb. 17, 1937).—In a floor for furnaces in which molten slag accumulates or runs over the bottom, the floor comprises a surface layer beneath which are cooling tubes and ridges including metallic projections above the tubes located along spaced lines transverse to the flow of the molten slag providing extra resistance to erosion thereby.

Furnace repair. H. H. Blau and K. K. Knaell (Carborundum Co.). U. S. 2,178,134, Oct. 31, 1939 (Oct. 20, 1937).—A method of repairing a tank or chamber for treating molten material while in operation comprises heating members of cast refractory having a greater specific gravity than the molten material to substantially the temperature of the molten material, depositing the heated members through the molten material in overlapping relation to form a covering layer on a wall of the tank in contact with the material, and supporting the members within the angle of repose.

Furnace wall and part thereof and method. J. N. Pyster and C. W. Stuke. U. S. 2,174,597, Oct. 3, 1939 (Sept. 23, 1937).

Furnace wall structure. G. W. Davey. U. S. 2,174,-871, Oct. 3, 1939 (Jan. 23, 1937).

Insulated wall for open hearths. E. J. Parsons. U. S. 2,173,764, Sept. 19, 1939 (Nov. 7, 1938).

Insulating brick. J. A. Vanden Broeck. Fr. 833,-927, July 7, 1937. D.A.B.

Lining smelting furnaces. J. A. Heskett. U. S. 2,175,291, Oct. 10, 1939 (Jan. 3, 1938).—A reverberatory furnace for smelting phosphate rock, siliceous limestone, or other like basic materials has means for cooling its internal surfaces associated therewith, in which such surfaces are coated with a coating of the material being smelted, applied thereto by a method under which a quantity of the material in a molten state, contained within the furnace, is caused to be splashed over the surfaces by means of jets of compressed air, steam, or other gases directed into the molten mass and is then rapidly cooled by the cooling of the surfaces to which it is applied.

Melting tank and apparatus for cooling seams thereof. H. H. Blau and K. K. Knaell (Carborundum Co.). U. S. 2,174,458, Sept. 26, 1939 (Oct. 15, 1937).

Open-hearth furnace. W. A. Morton (Amco, Inc.). U. S. 2,176,270, Oct. 17, 1939 (Dec. 17, 1937).

Preparing aluminates. Hans Zirngibl (I. G. Farbenind. A.-G.). U. S. 2,176,444, Oct. 17, 1939 (July 2, 1938).—A process of preparing aluminates comprises directly heating a mixture of a member of the group consisting of bauxite, alunite, aluminum sulfate, and aluminum sulfite with a member of the group consisting of alkali and alkaline-earth sulfates in an oxidizing atmosphere to about 600° to 700°C and reducing the mixture in steps without sintering at a temperature up to about 1200° to 1300°C, the chief reduction being carried out below about 1000°C with an undercharge of the reducing agent, the final reduction being carried out only with a gaseous reduction agent in the presence of a member of the group consisting of steam and carbon dioxide.

Refractory compositions. W. W. Constantine (General Motors Corp.). Brit. 512,877, Oct. 11, 1939 (March 25, 1938).

Refractory-material production. H. H. Chesny and A. L. Bradley (British Periclase Co., Ltd.). Can. 383,-532, Aug. 22, 1939 (Dec. 9, 1937).—A process for producing a dead-burned refractory material consists in feeding a slurry of finely divided magnesium hydroxide-containing raw material into the upper end of an inclined, rotary, internally heated, cylindrical kiln, subjecting it to conditions such that dead-burning takes place during passage through the kiln, and limiting dust loss by maintaining the gas-stream velocity between 125 and 225 ft. per min. by regulation of the gas temperature at the various zones of the kiln in relation to the free cross-sectional area at those zones. G.M.H.

Regenerative metallurgical furnace. L. B. Lindemuth. U. S. 2,176,674, Oct. 17, 1939 (Sept. 7, 1938).

Self-anchoring ceiling and wall tile. Louis Del Turco. U. S. 2,175,070, Oct. 3, 1939 (Oct. 15, 1938).

Tuyère. Karl Steinbacher. U. S. 2,178,654, Nov. 7, 1939 (July 30, 1938).

Wall support. C. W. Dunlap (Plibrico Jointless Firebrick Co.). U. S. 2,178,782, Nov. 7, 1939 (Nov. 10, 1938).

Zirconia zircon silicon refractory. J. D. Morgan (Power Patents Co.). U. S. 2,179,982, Nov. 14, 1939 (March 17, 1937).—A method of making a bonded refractory comprises mixing about 16 to 66 parts by weight of finely crushed zirconia (through 200-mesh) with 2 to 8 parts by weight of milled grain zircon, wetting the mixture with water and about 6 parts by weight of phosphoric acid to a creamy consistency, reducing the mixture to the consistency of a thick paste by digestion for several hours at a temperature ranging from about 200° to 350°F, adding water to increase the fluidity of the mixture and thoroughly admixing therewith about 76 to 20 parts by weight of coarsely ground ferrosilicon (10- to 60-mesh), digesting the mixture while agitating it and while heat drying the mixture to a suitable consistency for casting and shaping, and drying and heat-hardening the product.

Terra Cotta

Making roofing tile impervious. Chemical Laboratory for Clay Industry. *Tonind.-Ztg.*, **63** [14] 151–52 (1939).—Five types of roofing tile were treated with a solution of Imprägnol in water. In four cases the permeability was decreased sufficiently to conform to the standard specifications. W.K.

Tilework in the Tyrol and Salzburg country. Michael Birkenbihl. *Sprechsaal*, **72** [33] 421–33; [34] 438–42

(1939).—The Tyrol and Salzburg have been art and handicraft centers for 700 years. Tile stoves of fine proportion and elaborate design were being made in the Tyrol as early as 1200. Nürnberg is credited with having introduced the technique of faience making into Germany from Italy, but the Tyrol adopted it about the same period. Many fine examples of tile stoves made during the early Renaissance period are illustrated and described. Typical of this type of old stove is the large tiled fire box of rectangular form which usually rests on figures of lions and which is surmounted by a cylindrical superstructure or dome of elaborately designed tile. From archives on the origin of the tile stoves of the Austrian Alps it has recently been definitely established that the monogram "H R" found on many of the finest stoves referred to Hans Resch who lived in the last half of the 16th century and was the master artisan who made the stoves; he was given many commissions by princes and clergy for stoves to be placed in castles, churches, and public buildings. Ceramic art in Salzburg was at its height during the early Renaissance but began to decline soon after 1600. The most famous examples of these old tiled stoves are now in the museums of Germany. M.V.C.

Wet engobing. H. LINGL. *Tonind.-Ztg.*, **63** [32] 370–71 (1939).—L. discusses the development and modern practice of applying an engobe directly to a column issuing from the extruding machine, with special reference to roofing tile. W.K.

PATENTS

Apparatus for finishing flat and curved tile. SOC. ANON. D'EXPLOITATION DE LA GRANDE TUILERIE MÉCANIQUE PERRUSSON DE FONTABIE. Fr. 48,694, Aug. 9, 1937; addition to 820,532. D.A.B.

Roofing tile. J. LAURENTIES. Fr. 849,135, Jan. 20, 1939. D.A.B.

Whiteware

Decorating 300,000 spark plugs daily in 60-ft. kiln. ANON. *Ceram. Ind.*, **33** [5] 36–38 (1939).—At the plant of the Champion Spark Plug Co., Detroit, Mich., a new 60-ft. kiln being put in operation is of the muffle type, both overfired and underfired with radiant tubes; it will be fueled with natural gas for 8 months of the year and with butane for 4 and will replace 7 electrically fired nickel-tube kilns. The new unit will enclose a tunnel 1 ft. x 2 ft. in section. The kiln will operate at 1400°F and will handle 300,000 insulators of assorted sizes per day. For the past 10 years, the plant has used two pilot kilns, similar in design to the new production unit but of smaller capacity. Ware is charged into the new kiln by placing 38 to 54 freshly imprinted insulators, depending on size, onto vertical pins bristling a metal tray, the whole being of nickel-chromium steel designed to resist high temperatures. A hydraulic pusher is used. A beam of light is focused along the tunnel and received in a photoelectric unit at the outlet end so that if the line of trays buckles, the pusher circuit is broken, the movement is stopped, and the operator is warned to clear the muffle manually or otherwise correct the error before operation can be restored. As insulators of all sizes must be decorated, trays filled with one size are alternated with others in accordance with a fixed sequence or pattern worked out so as to keep an even insulator load in the muffle at all times. Otherwise the smaller cores would be overfired and the larger ones underfired at the same heat input to the kiln. L.M.C.

Early history of the electrical porcelain industry in the United States. ARTHUR S. WATTS. *Bull. Amer. Ceram. Soc.*, **18** [10] 404–408 (1939).

Porcelain as substitute for metals in dairy equipment. M. KRAUSE. *Umschau*, **43** [12] 270 (1939).—As much porcelain as possible is used instead of metals for dairy equipment, due to the shortage of metals in Germany. A centrifuge completely made from hard porcelain is available. J.M.N.

Stresses in porcelain glazes. A. L. JOHNSON. *Jour. Amer. Ceram. Soc.*, **22** [11] 363–66 (1939).

Talc porcelain: XVI. SEIJI KONDO AND SHIN-ICHI SUZUKI. *Jour. Soc. Chem. Ind. Japan*, **41** [11] 810–13 (1938); in Supp. Binding, p. 386B.—The softening behavior was studied for seven bodies consisting of 90 to 30% talc and 10 to 70% Korean kaolin and seven other bodies consisting of 10 to 80% talc, 10 to 90% kaolin, and 0 to 10% feldspar. The results are as follows: (1) the vitrification ranges of talc-kaolin bodies narrow with increasing amounts of talc; highly talcous bodies cannot be improved by an introduction of feldspar; (2) the rapid melting of talc-kaolin bodies is probably due to the low viscosity of the most fusible eutectic in the system magnesia–alumina–silica as well as its high thermal coefficients; (3) bodies containing more magnesium silicate than the eutectic melt still more rapidly; (4) experimental data on the equation $T = Ce^{-Kw}$ indicate that the melting points of bodies are rapidly lowered with a decrease in C and an increase in K; (5) the average coefficients of linear expansion of talc-kaolin porcelains at temperatures between 0° and 600° can be expressed by a quadratic equation of the molecular ratio of alumina to silica or of the molecular content of magnesia. **XVII.** *Ibid.*, **42** [3] 154–56 (1939); in Supp. Binding, p. 88B.—The resistance of 14 porcelain bodies composed of RO, alumina, and silica to the action of mineral acids has been studied. The chemical composition of the bodies is 0.07 to 0.26 CaO, 0.93 to 0.74 MgO, 0.62 to 1.445 Al_2O_3, and 1.09 to 3.35 SiO_2. The bodies were fired to the lowest vitrifying temperature and, after being powdered and sieved, were treated with H_2SO_4, HCl, and HNO_3 solutions. The solubility is given by the loss in weight. The relation between the solubility and the molecular ratio of silica to alumina ranging between 2.30 and 19.37 is computed for the purpose of obtaining acidproof porcelains of low talc bodies which are highly resistant to thermal shock. Results of the experiments are as follows: (1) sulfuric acid acts more severely than the other two; (2) the relation between the dissolved amount, S, and the molecular ratio of alumina to silica, R', can be expressed by an exponential equation, $\log S = (-A/R') + B$, where A and B are constants depending on the kind and concentration of the acids; (3) the dissolved talc porcelains amounted to 0.27 to 8.20% with sulfuric acids, 0.50 to 13.66% with hydrochloric acids, and 0.52 to 14.19% with nitric acids; (4) acid resistance of the low talc bodies decreases suddenly when the molecular ratio of silica to alumina falls below 10.0; (5) talc porcelains which resist thermal shock and the action of acids well can be easily obtained. For Parts **XIV–XV** see *Ceram. Abs.*, **18** [4] 105 (1939). M.T.

PATENTS

Bushing. A. A. SKVORTZOFF (Westinghouse Electric & Mfg. Co.). U. S. 2,179,356, Nov. 7, 1939 (May 21, 1936).

Ceramic body for spark-plug insulators. T. G. McDOUGAL, A. H. FESSLER, AND H. B. BARLETT (General Motors Corp.). U. S. 2,177,943, Oct. 31, 1939 (Sept. 7, 1938).—A spark-plug insulator in the form of a dense, nonporous body consists of a sintered mixture of corundum and 0.5% to 80% tantalum oxide.

Ceramic insulating material containing titanium dioxide to be used as dielectric in condensers. ROSENTHAL-ISOLATOREN G.M.B.H. Fr. 840,282, July 5, 1938. D.A.B.

Composite body. HANS PULFRICH (General Electric Co.). U. S. 2,174,390, Sept. 26, 1939 (June 22, 1937).—In a composite body, a low dielectric loss ceramic material is composed of the product of firing at an elevated temperature a mixture consisting of, by weight, about 10 to 40 parts beryllium oxide, about 15 to 36 parts hydrous magnesium silicate, and about 36 to 67.5 parts hydrous aluminum silicate, the ceramic material having a coefficient of linear thermal expansion not substantially exceeding 50×10^{-7} per °C.

Fixation of metallic pieces in porcelain. H. CATU. Fr. 840,381, Dec. 31, 1937. D.A.B.

Frangible tableware. RICHARD RATNER. U. S. 2,178,274, Oct. 31, 1939 (Jan. 11, 1939).

Gastight ceramic parts. "OSA" PARTICIPATIONS INDUSTRIELLES (SOC. ANON.). Fr. 831,688, Jan. 5, 1938. D.A.B.

High-quality dielectric from ceramic products. "FIDES" GES. FÜR DIE VERWALTUNG UND VERWERTUNG VON GEWERBLICHEN SCHUTZRECHTEN M.B.H. Fr. 840,712, July 15, 1938. D.A.B.

Insulator. A. O. AUSTIN (Ohio Brass Co.). U. S. 2,173,292, Sept. 19, 1939 (May 17, 1930; Jan. 10, 1935).

Joint for ceramic materials. C. M. CARINGTON (K. L. G. Sparking Plugs, Ltd.). U. S. 2,174,913, Oct. 3, 1939 (March 29, 1939).

Making ceramic articles. R. E. GOULD. U. S. 2,173,107, Sept. 19, 1939 (Aug. 9, 1937).—In a process of making a plurality of ceramic flatware articles which have substantially identical dimensions, the steps comprise superposing for subsequent firing a plurality of ceramic elements comprising a plurality of leather-hard ceramic articles preformed from plastic material, a leather hard ceramic separating element preformed from a plastic material which has substantially the same physical properties as the plastic material from which the ceramic articles are formed supporting each ceramic article in the zone of greatest potential deformation during firing, a leather-hard setter preformed from a plastic material which has substantially the same physical properties as the plastic material from which the ceramic articles are formed, with at least a part of the obverse of the setter substantially identical to the obverse of the leather-hard ceramic articles, and a fired refractory setter, with the obverse of the fired setter complementary to the reverse of the leather-hard setter.

Method and apparatus for testing spark plugs. C. C. SOPER (Firestone Tire & Rubber Co.). U. S. 2,175,038, Oct. 3, 1939 (Aug. 8, 1938).

Method and mold for casting vitreous closets in two parts. C. W. LASCHENSKI (American Radiator & Standard Sanitary Corp.). U. S. 2,175,730, Oct. 10, 1939 (March 16, 1937).

Porcelain-surface protection. F. B. JOHNSON (Westinghouse Electric & Mfg. Co.). U. S. 2,179,297, Nov. 7, 1939 (Sept. 8, 1938).

Porcelain teeth, etc. ERDLE & PRANCE, INC. Fr. 825,424, Aug. 9, 1937. D.A.B.

Producing colored flatware. EDWARD SCHRAMM (Onondaga Pottery Co.). U. S. 2,174,198, Sept. 26, 1939 (Dec. 30, 1938).—A method of producing surface-colored American vitreous chinaware consists in shaping the ware from body material in a moist condition and of such composition as to be fused and sintered by a biscuit firing operation into a hard vitreous body characteristic of American vitreous chinaware, drying the shaped ware and thereafter coating the ware surface to be colored with an engobe comprising a pigmented material, biscuit firing the coated ware, the pigmented material being of such composition that it is fused and sintered by the biscuit firing operation into a colored surface portion of the ware in permanent adherence and similar in hardness and in its vitreous character to the fused and sintered body, applying a decorative design to the engobe-treated surface of the biscuit-fired ware, coating the ware with glaze-forming material, and then glaze firing the ware at a temperature below the biscuit-firing temperature.

Safety core insulator. A. O. AUSTIN. U. S. 2,175,336, Oct. 10, 1939 (June 18, 1936).

Spark plug. EARL E. BIDWELL (Productive Inventions, Inc.). Can. 383,116, Aug. 1, 1939 (Oct. 5, 1937). G.M.H.

Spark plug. J. A. DORAN. U. S. 2,174,362, Sept. 26, 1939 (Oct. 4, 1932; May 24, 1939). J. D. FOWLER. U. S. 2,173,607, Sept. 19, 1939 (Sept. 16, 1937). W. M. HART. U. S. 2,174,978, Oct. 3, 1939 (Oct. 13, 1938). A. C. HASTINGS, JR. Brit. 513,297, Oct. 18, 1939 (Feb. 11, 1938). J. P. KLETZ. U. S. 2,180,242, Nov. 14, 1939 (Feb. 17, 1939). E. F. KOEHLER AND RICHARD HARDEN (E. F. Koehler and G. W. Goerner). U. S. 2,176,858, Oct. 17, 1939 (Jan. 6, 1937). GUSTAV RUTHARDT. U. S. 2,178,348, Oct. 31, 1939 (April 14, 1938). CHARLES SMITH (J. H. Theis). U. S. 2,179,801, Nov. 14, 1939 (April 7, 1939). K. WERTH. Brit. 513,382, Oct. 25, 1939 (July 11, 1938).

Spark-plug construction. E. E. BIDWELL (Productive Inventions, Inc.). U. S. 2,179,609, Nov. 14, 1939 (Nov. 20, 1937).

Equipment and Apparatus

Air conditioners using glass fibers. ANON. *Verre & Silicates Ind.*, **10** [22] 259 (1939).—The Abair air conditioner is composed of one or more capillary cells in a mixing chamber into which water is introduced. The capillary cell is in the form of a rectangular parallelepipedon and is composed of an exterior envelope filled with glass fibers, the top and bottom layers of which are placed horizontally and connected with a screen of vertical fibers. The upper and lower faces of the envelope are formed of a network of iron wire. A standard capillary cell of 500 x 500 x 215 mm. contains about 57,000 glass fibers of 0.3 mm. diameter. The air treated is drawn into the mixing chamber and through the capillary cell. The water travels parallel with the air and drops through fibers in the cell where it absorbs dust and bacteria (up to one micron) from the finely divided air currents passing through the glass fibers. M.V.C.

Air purification. E. L. JOSEPH. *Heating & Ventilating Engr.*, **11** [132] 594 (1938).—Contamination of the air by solid impurities may be reduced by wet and dry filters, some of which are described. Illustrated. R.H.

Apparatus for modern measurement: Brown potentiometer. V. BROIDA. *Chaleur & Ind.*, **20** [230] 434–35 (1939).—B. discusses the mechanism and accuracy of the Brown self-balancing recording potentiometer for use in thermoelectric pyrometry. A sensitivity of 0.2% of the total scale is reported. V.D.F.

Behavior of amorphous and crystallized quartz in the electrostatic field. O. GAYLING VON ALTHEIM. *Ann. Physik*, **35** [5] 417–44 (1939).—The behavior of dielectric material under continuous current is discussed and experimentally investigated. The general conclusions show that in both amorphous and crystallized quartz the currents produced by d.-c. potentials are composed of polarization and conductive currents; the order of the current for temperatures up to 250°C at 200 v. was 2×10^{-18} to 2×10^{-19} amp./cm.^{2}. Charging and discharging currents were proportional to the voltage. The dielectric constant was practically independent of temperature. M.H.

Ceramic trimmer condensers. UNITED INSULATOR CO. *Jour. Sci. Instruments*, **16** [8] 273–74 (1939).—A new bijou type of ceramic trimming condenser is described and illustrated. J.L.G.

Classified grinding research. L. ANDREWS. *Bull. Inst. Mining & Met.*, No. 409, pp. 1–25 (1938).—The theory of fine grinding is reviewed, and standard units of measurement dealing with surface area, particle diameter, carrying velocity, etc., are suggested. A. refers to the large waste heat loss associated with commercial grinding and suggests that the rise in temperature in a wet-grinding mill is due chiefly to the molecular stretching and shearing of the liquid film between adjacent solid particles and to the molecular agitation induced in solid particles which are not fractured by blows received. Illustrated. R.H.

Direct measurement of silicate heats of melting. HOWARD S. ROBERTS. *Amer. Jour. Sci.*, **35A**, 273–87 (1938).—The reluctance of most silicates to crystallize makes it difficult to obtain their heat of melting when using a calorimeter operated at room temperature. R. describes a high-

temperature calorimeter which measures with usable precision the energy absorbed by the silicates in melting. The heat of melting of K_2SO_4 at 1069°C is 46.5 cal./g. with an accuracy of 2%. The heat of inversion is 8.8 cal./g. with an accuracy of 7%. The latent heat of fusion of impure Na_2SiO_3 melting at 1089°C is 100 cal./g. J.B.A.

Driers and drying. CHARLES R. FILIPPI. *Brit. Clayworker*, **48** [568] 170–71 (1939).—F. discusses the importance of the drier in a ceramic plant and the necessity of proper control under varying conditions of manufacture of clayware. R.A.H.

Drying in natural and artificial driers. P. THOR. *Tonind.-Ztg.*, **63** [10] 104–107; [12] 130–32 (1939).—Air drying sheds should be spaced properly to allow the access of fresh air. An efficient way to dry roofing tile is to place them on inclined racks down which the tile slide while drying. In all driers over ring kilns a good insulation of the roof is important to prevent the condensation of moisture. T. discusses his system of chamber driers. W.K.

Effect of grindability on particle-size distribution. R. M. HARDGROVE. *Trans. Amer. Inst. Chem. Engrs.*, **34**, 131–52 (1938).—The use of laboratory tests of grindability as a guide in determining expected performance of pulverizers and in studying the characteristics of various materials has proved very valuable. Grindability is defined as the index which represents how many tons per hour can be pulverized to a stated fineness on a given pulverizer. A table of grindability for miscellaneous materials is given. The conclusions are as follows: (1) products having a higher crushing resistance indicate a lower surface for the same screen size, (2) knowing the grindability and specific gravity, an approximate estimate of the surface can be made for a given screen size, (3) the type of pulverizers or arrangement of circuit has a minor effect on the particle size distribution compared with the effect of crushing resistance. A discussion is included. See *Ceram. Abs.*, **17** [9] 310 (1938). H.E.S.

Electrical measurement of high temperatures. YVON LAURE. *Electricité*, **23** [57] 183–90 (1939).—L. gives a description of resistance thermometers and thermocouples for industrial and precision uses including their construction, measuring methods, and calibration. Precision thermocouples are graphite-silicon carbide and 50% Ni + 50% Cu-84% Ni + 16% Mo. In industrial use are the combinations Pt-92% Pt + 8% Re, Pt-90.5% Pt + 4.5% Re + 5.0% Rh, Rh-99.92% Rh + 0.08% Re, Au-68% Au + 32% Pd, Pd-60% Pt + 40% Pd, Te-Pt, Pt-99% Te + 1% Sb, 95% PtRh + 5% Re-Pd + Au, 60% Fe + 40% Cr-Pd, Cu-constantan, Fe-constantan, Ag-constantan, Ni-Ni steel, Ni-graphite, Ni-NiCr, 84% Ni + 16% Mo-50% Ni + 50% Cu, NiCr-NiAl, W-75% W + 25% Mo, and graphite-silicon carbide. The millivolts are given for all these thermocouples, and calibration curves are shown for most of them. J.M.N.

Employment of photoelectric cells of selenium for precision photometry. J. TERRIEN. *Compt. Rend.*, **209** [5] 300–301 (1939).—The disadvantages of Se cells, viz., that they give satisfactory results only if the two light sources to be compared have approximately the same color and that the spectral sensitivity of the eye is different from that of the Se cell, are eliminated or at least greatly reduced by a modified measuring process; the source to be determined and the standard lamp are placed at such a distance from each other that the reaction on the cell is the same in both positions; the ratio of the square of the distances gives the intensity. As the Se cells are more sensitive with lamps of not too high temperature, the tests are best made in a temperature range of 2045° to 2360°K. Photometric equipment for rapid measuring is briefly dealt with. M.H.

Filtration of clay solutions. P. P. EKIMOV. *Razvedka Nedr*, **8**, 60–61 (1938); abstracted in *Chem. Zentr.*, **1939, II**, 503.—Filtration of clay suspension is better achieved with a pressure of 1.5 than in a vacuum. The coefficient of filtration is determined from the filtrate within 30 min. M.V.C.

Grinding process. H. G. WOLFRAM. *Bull. Amer. Ceram. Soc.*, **18** [10] 374–75 (1939).

Haulage for brick. J. W. WHITE. *Brit. Clayworker*, **48** [567] 130–40 (1939).—W. discusses the three types of conveyances used for transporting clay in brick plants, i.e., tramways, motor vehicles, and aerial ropeways. R.A.H.

Horizontal carriage of granular material by an injector-driven air stream. S. A. WOOD AND A. BAILEY. *Trans. Inst. Mech. Engrs.* [Preprint], March 31, 1939.—An investigation was made of the pneumatic transport of sand (50-mesh) and linseed in a horizontal direction by means of a stream of air applied through an injector with an annular high-pressure nozzle surrounding the conveyer pipe. Tests showed that there is a definite optimum position for the injector, viz., near the middle of the conveyer pipe, and that a divergent diffuser at the outlet is an advantage. Definite relations exist between (*a*) the air velocity and the rate at which the solid matter is conveyed, and choking occurs if the air velocity is insufficient; (*b*) the pressure gradient in the pipe and the air pressure in the injector; this is steepest at the inlet and diminishes until it reaches a steady value; the distance taken to reach this value is constant; and (*c*) the additional drop in pressure due to the grains and the rate at which they travel. The pressure gradient in the uniform region is constant for all values of the solid/air ratio at a given injector pressure. The maximum mass of a given solid which can be transported continuously is proportional to the injector pressure so that the ratio, mass transported per min./high-pressure air used per min., is constant for each material. This constant for linseed is 1.6 times that for sand. There are indications that the effective coefficient of friction between the grains and the pipe falls as the grain velocity increases. Visual observation shows that the particles travel in a series of leaps whose length increases with the grain speed. This form of pneumatic transport has been used for conveying Portland cement a distance of 5600 ft. in a single stage at rates up to 76 tons per hr. and for conveying pulverized coal in stages up to 6000 ft. Illustrated. A.B.S.

Instrument for measuring surface roughness. PHYSICISTS RESEARCH CO. *Jour. Sci. Instruments*, **16** [8] 274–75 (1939).—A portable Profilometer is described and illustrated. See "Measuring—," *Ceram. Abs.*, **17** [7] 240 (1938). J.L.G.

Iron molds made by electroforming. ANON. *Ceram. Ind.*, **33** [4] 82 (1939).—An inexpensive method of mold making, used by the U. S. Rubber Co., consists in electroforming iron against the pattern to be reproduced. A mass of metal up to $^1/_2$ in. in thickness may be built up by this method. The pattern to be produced may be of metal, wood, glass, plastics, or similar materials. A rubber negative is prepared against the original and it serves as a pattern for the electroformed duplicate. Nonmetallic original models are made conductive by dusting them with powdered graphite which when polished gives the finished electroformed cavity an excellent finish. The mold thus formed is of electrolytic iron, about 99.98% pure and nonporous. It is 50% harder than cold-rolled steel and can be softened by annealing or hardened by carburizing. Its heat conductivity is about twice that of cast iron. L.M.C.

Measurement of temperature by thermoelectric couples. S. S. HELD. *Chaleur & Ind.*, **20** [230] 387–421 (1939).—The theory of temperature scales and their standard points are discussed, and methods of temperature measurement over the various ranges between −200°C and 2800°C are given, with equations fundamental to their use. Pt-PtRh couples may be used up to 1800°C and rhodium-rhodium rhenium or iridium-ruthenium may be used up to 2000°C. Above this point, optical methods must be used. H. gives the temperature-e.m.f. relations of eight common couples, together with a detailed thermodynamic treatment of the Peltier, Thompson, and Becquerel effects, and means of eliminating parasitic effects. A discussion of a choice of metals for couples includes a table of the potentials developed between platinum and each of twenty-two metals when the hot junction is at 100°C and the cold junction is at 0°C. Fine couple wires are desirable for eliminating

thermal lag of the couple, but, for high temperatures, particularly in unfavorable atmospheres, the wire diameters should not be less than 2 mm. For rare-metal couples, the diameter varies from 0.5 to 0.6 mm. Materials for insulation and protection of the couples in service are discussed. A list of melting points and boiling points of materials is given for standardization of couples. Diagrams show eleven electrical circuits for the compensation of the e.m.f. introduced in the wires leading from the couple wires to the potentiometer. H. proposes an instrument for measuring the e.m.f. of a couple, avoiding the necessity for manual control or complicated mechanisms. Two trielectrode valves are used as amplifiers, the resulting current in the valve circuit being measured by a quadrant galvanometer. The e.m.f. of the couple cannot be rigorously nullified over a range of temperature for a single setting of the instrument, but the current flow in the couple circuit is reduced to an insignificant value, so that it is essentially the e.m.f. and not a current flow that is measured. The application of thermopiles for radiometry and for augmenting the accuracy of the reflection galvanometer is discussed briefly. The use of selenium, tellurium, silicon, and bismuth with silver or platinum is noted. Instruments for measuring electric currents and potentials of thermopiles and thermocouples designed to measure the temperature rise in a standard resistance are described. Optical and radiation pyrometers and the use of thermocouples in the automatic regulation of high temperatures are briefly considered. Errors common in the use of thermocouples, e.g., change in the constitution of the wires, faulty insulation, damage to the couple, improper placing of the couple, etc., are given, together with means of avoiding them. A diagram shows the possibility of using the same temperature-reading galvanometer with any set of couple wires, by insertion of proper resistance in series. V.D.F.

Measuring the adsorption of gases and vapors on solids. H. H. CHAMBERS AND A. KING. *Jour. Chem. Soc.* [London], **1939,** p. 139.—Adsorption and desorption are measured directly by means of a Nicholson hydrometer floating in mercury and carrying the adsorbent in the pan. The whole apparatus is immersed in a thermostat. The float carries a load of 6 g. of adsorbent and has a sensitivity factor of 15 mg per mm. movement. R.A.G.

Movement of air and heat in driers. KARL SPINGLER. *Tonind.-Ztg.*, **63** [16] 173–75 (1939).—S. discusses the principles of drying. W.K.

Ni-Hard in clayworking machinery. ANON. *Nickel Bull.*, **11,** 262–64 (1938).—The conclusions reached by J. O. Everhart (*Jour. Amer. Ceram. Soc.*, **21** [2] 69–72 (1938)) regarding the value of nickel alloy cast iron pug mill knives, grinding mill plates, muller tires, ploughs, dieliners, and other parts of clayworking machinery requiring special wear-resisting properties have been confirmed in practice. L.R.B.

Opaque ultracentrifuges for direct analysis. JAMES W. MCBAIN. *Jour. Phys. Chem.*, **42,** 1063 (1938).—Various forms of inexpensive opaque rotors have been used for measurements of sedimentation velocity and of sedimentation equilibrium, and the results obtained are as accurate as those obtained with the best transparent ultracentrifuges. R.A.G.

Particle-size reduction and separation. W. H. COGHILL AND F. D. DEVANEY. *Trans. Amer. Inst. Chem. Engrs.*, **34,** 113–29 (1938).—The history of particle-size reduction is traced from the earliest method mentioned by Agricola, which was "fire-setting," up to present-day machinery methods. Crushing is divided into the following classes: (1) primary crushing, which consists of an initial crushing or breaking of run-of-mine or quarry material; the machines must be able to handle large pieces and be rugged in construction as are jaw crushers, gyratories, hammer mills, and rolls; (2) secondary crushing, which covers the reduction of material that has been given a preliminary crushing to reduce it to an intermediate size; there are a multiplicity of crushers in this field such as short-head gyratory, Symons cone, rolls, and hammer mills; and (3) fine grinding, which is the final or complete reduction in size; it is usually done in either rod or ball mills. Results of detailed grinding studies over a great number of years are given. The tests cover such operating variables as speed, pulp consistency, shape of mill, ball or rod load, ore volume, size and shape of grinding medium, etc. The particle-size separation is discussed under the following subjects: (1) removal of fines ahead of a crushing or grinding machine, thus preventing overloading or the production of unwanted fines; (2) grading into series of size increments such as in the production of crushed stone or gravel for road material or concrete aggregate; and (3) control of the size of the material finished by any particular machine. See "Ball-Mill—," *Ceram. Abs.*, **17** [7] 258 (1938). H.E.S.

Periodic flow of heat in a hollow cylinder. J. H. AWBERY. *Phil. Mag.*, **28** [189] 447–51 (1939).—The problem of the flow of heat in a hollow cylinder is investigated mathematically when the temperature of the inner wall is regulated to vary periodically and the heat loss from the outer surface is proportional to its temperature excess over the surroundings. See "Temperature—," *Ceram. Abs.*, **17** [7] 264 (1938). R.H.

Photography of fine dust particles. D. G. BEADLE. *Jour. Sci. Instruments*, **16** [8] 262–63 (1939).—B. shows that by using great contrast, both optically and photographically, more dust particles can be photographed than can be seen visually. Using a 2 mm. oil immersion microscope objective, N. A. 1.3, about 75% more particles were photographed than were visible in the same field using the same objective under the best visual conditions. The contrast conditions are described in detail. J.L.G.

Photometric dust determinations. ANON. *Iron Age*, **144** [1] 46 (1939).—The apparatus consists of a constant source of light (obtained by controlling the voltage of the current supplied to a tungsten filament lamp), a lightproof chamber for the container holding the dust suspension, a photoelectric cell (in the lightproof chamber), and a meter outside. The method will be chiefly used as a control for industrial operations. A table shows results with dust from a brick plant. The test was made by the West Virginia State Department of Health. E.H.McC.

Preparing finely powdered substances for grain-size determination. ANON. *Sprechsaal*, **72** [32] 413–14 (1939).—A simple, quick method of preparing slides of substances pulverized finer than those for ordinary screen analysis for microscopical determination of the grain size consists in placing a minute quantity of the powder on the slide, moistening it with water or with methyl alcohol, spreading it evenly to a thin film, and evaporating it to dryness. Skill in obtaining sufficiently thin dispersion of particles to be able to observe their size and outline is acquired by practice; if the ratio of the substance to the suspension liquid is correct, the particles of substance can be easily detected and compared with a micrometer scale to ascertain the mean or maximum grain size. M.V.C.

Psychrometric chart; application and theory: II. WILLIAM GOODMAN. *Heating, Piping & Air Conditioning*, **11** [7] 421–24 (1939).—G. continues his explanation of the use of the psychrometric chart and illustrates the method with sample calculations. III. *Ibid.*, [8] 485–87.—Several equations important in the use and understanding of the new psychrometric charts have been developed. V. *Ibid.*, [10] 613–15, 617, 627–28.—G. discusses the location of wet-bulb lines and mixtures of air and steam. Illustrated. For Part I see *Ceram. Abs.*, **18** [10] 276 (1939). J.L.G.

Psychrometric measurements; the Psychrobac. PAUL MONDET. *Chaleur & Ind.*, **20** [230] 425–31 (1939).—Hygrometric apparatus for the determination of relative humidity by the change in length of organic fibers has the disadvantages of hysteresis, necessity for frequent calibration, and uncertainty when used over a range of temperatures. Psychrometers, making use of wet- and dry-bulb temperature measurements, eliminate these sources of error. A detailed discussion of the fundamentals of psychrometry is presented, linking weight percentage of moisture in air, partial pressure of water vapor, temperature lowering by evaporation of water, and relative humidity

The "zone of comfort" (range of relative humidity that is found pleasant at any given temperature) usually lies between 30% and 75%. The Psychrobac is a new French direct-reading psychrometer. Two bimetallic thermometers, one dry and the other moistened with distilled water, operate long curved pointers of fine hollow aluminum tubing. These indicate the wet- and dry-bulb temperatures, and their point of intersection allows direct reading of relative humidity on a central scale. A small electric fan maintains a constant velocity of air past the thermometers. V.D.F.

Pumping device. E. B. GEORGE. *Bull. Amer. Ceram. Soc.*, **18** [10] 363–67 (1939).

Recirculating radiated waste-heat drier operated under controlled humidity and temperature. H. R. STRAIGHT. *Bull. Amer. Ceram. Soc.*, **18** [11] 427–29 (1939).

Spraying equipment. VIELHABER. *Emailwaren-Ind.*, **16** [31–32] 207–208 (1939).—When mechanical spraying equipment is installed, it is important to determine by experiment the most suitable air pressure, nozzle size, and enamel grain size. It is better and more economical to use a larger sized nozzle and greater air pressure, although the size of the objects to be sprayed is a limiting factor. Power consumption for compressors, ventilators, and suction apparatus and operation costs in Germany are compared. M.V.C.

Standard air filter test dust. FRANK B. ROWLEY AND RICHARD C. JORDAN. *Heating, Piping & Air Conditioning*, **11** [10] 633–38 (1939).—Numerous tests on various ashes and carbons indicate that carbon black and Pocahontas coal ash satisfy the requirements of a standard test dust if controlled within reasonable limits as to density and rate of burning. Pocahontas ash (80% by weight) screened through 200-mesh and having a jolted density of between 0.65 and 0.85 g. per cc. mixed with 20% by weight of Double Bolted Carbon Dust screened through 100-mesh and having a jolted density of between 0.145 and 0.18 g. per cc. is recommended as a standard test dust for use in the general rating of air filters on a weight basis in the laboratory. 12 tables, 5 figures. J.L.G.

Study and use of thermoelectric couples, especially multiple thermocouples. H. CARRA. *Chaleur & Ind.*, **20** [230] 432–33 (1939).—C. describes a calorimeter for the measurement of specific heats of gases and a calorimeter for measurement of the calorific values of gases. Thermopiles are used to measure the thermal gradients. V.D.F.

Synchronizing the illumination for an ultracentrifuge. YNGVE BJORNSTAHL. *Jour. Sci. Instruments*, **16** [8] 254–56 (1939).—The ultracentrifuge makes it possible to measure the sedimentation velocity by means of optical methods while the centrifuge is running at very high speeds. If centrifuge rotors of oval shape are used in order to increase the bursting strength, an intermittent light source is necessary. The light flashes must be in synchronism with the speed of the rotor. Several methods of synchronizing the illumination are described. 2 figures. J.L.G.

Temperature and humidity in artificial driers. A. TÄUBER. *Tonind.-Ztg.*, **63** [22] 253–55 (1939).—Measurements of the dry- and wet-bulb temperatures and the rate of drying in a chamber drier without artificial draft are presented and discussed. W.K.

Temperature-indicating paints. F. PENZIG. *Umschau*, **43** [35] 810–14 (1939).—Chemical paints are described which change the color at certain fixed temperatures. Fourteen paints cover the range of 40° to 650°C. Three additional materials have two and three changes ranging from 65° to 275°C. The composition is not given. Ni, Co, Cr, Cd, and U are mentioned as bases of the salts. Applications are described. The corrosion of glass kilns can be checked by using these paints on the outside. Places with too high temperatures (above 440°C) are plainly noticeable. See "Making—," p. 9. J.M.N.

Thermal conductivity determinations; new apparatus and procedure. W. F. CHUBB. *Metal Ind.* [London], **52** [21] 545–48; [22] 579–80 (1938).—A number of refinements which have been incorporated in the guard-ring method for the determination of the thermal conductivity of metals is described. The wiring diagram of the new apparatus is shown. C. also mentions the calibration method and, after summarizing the technique of the measurements, he gives examples of the accuracy obtainable with this method. H.E.S.

Thermocouples from noble metals. K. W. FRÖHLICH. *Österr. Chem.-Ztg.*, **42** [18–20] 356–57 (1939).—Thermocouples for use up to 1600°C are described. Changes of the result due to changes of 0.01% to 0.02% in the analysis of Pt and Rh are given. F. shows calibration tables for Pt-PtRh and Pt-PtRe thermocouples; the former gives 16.65 millivolts at 1600°C and the latter gives 33.07 mv. at 1350°C. Protection tubes are made from sintered pure oxides. J.M.N.

Three-dimensional photos record metal defects. R. C. GIBBONS. *Amer. Machinist*, **83**, 852–53 (1939).—To provide a spatial aspect of a defect, especially on the surface or a section of a material, two pictures are taken of it at two different angles (about 7° apart), and the negatives are viewed side by side in a stereoscope. G. describes the best procedure for taking the pictures and the precautions to be observed. M.H.

Use and economy of a rotary drier in the manufacture of brick and tile. J. W. WHITTEMORE. *Bull. Amer. Ceram. Soc.*, **18** [10] 367–68 (1939).

Viscosity of liquids at high hydrostatic pressures. R. B. DOW. *Phil. Mag.*, **28** [189] 403–22 (1939).—Various methods of high pressure viscometry are discussed. The Bridgman falling weight viscometer was used for determining the viscosity of carbon disulfide-carbon tetrachloride mixtures containing 15, 30, 50, 60, 65, and 75% CS_2 by volume at 30°C. The pressure range extended from atmospheric pressure to a pressure of 10,000 kg./cm.^{2}, and measurements were carried out at 30°C and 75°C. D. gives viscosity-pressure data at these temperatutes for concentrations of CS_2 varying from 0 to 100%. The coefficient of viscosity increased with increasing pressure and decreased with increasing CS_2 content, but the relation between the composition of the mixture and viscosity could not be expressed as a simple function. D. discusses the possibility of change in the degree of interlocking or aggregation of molecules with pressure and concludes that viscosity measurements at high pressure provide an excellent means for studying the molecular structures of liquids. R.H.

Wear resistance of gray cast iron, particularly of cylinder blocks and rifles. M. v. SCHWARZ. *Giesserei*, **25** [25] 637–42 (1938).—S. reports and discusses the results of tests made to determine the factors important for the wear of gray iron. Although the structure is of major importance, the material on which the cast Fe wears has a great influence. The structure of the cast Fe should be purely pearlitic with uniform fine graphite distribution and finely laminar pearlite, with a net of a narrow-meshed phosphide eutectic, as this structure shows the best wear resistance. A high P content in a fine phosphide net is favorable to a high wear resistance, but a cast Fe produced in an electric furnace had a high wear resistance even with as low as 0.12% P, due to the fine graphite formation and distribution. Uneven lapping of the surface of the test discs can cause the wear resistance to appear reduced to $^1/_{10}$ or less. M.H.

BOOK AND SEPARATE PUBLICATION

Bureau of Mines Midget Impinger. H. H. SCHRENK AND FLORENCE L. FEICHT. *U. S. Bur. Mines Information Circ.*, No. 7076. 7 pp. Free.—A description is given of the midget impinger flask and suction apparatus developed by the Bureau as well as the collecting and counting of dust samples. Results are given of laboratory tests with silica dust, lead dust, and lead fumes and field tests on catoctin greenstone and siliceous schist. See "Technique—," *Ceram. Abs.*, **18** [1] 29 (1939); "Efficiency—," *ibid.*, **17** [11] 361 (1938). R.A.H.

Theory and Practice of Industrial Drying. PAUL RAZOUS. Dunod, Paris. 4th ed. 92 fr unbound. Reviewed in *Verre & Silicates Ind.*, **10** [25–27] 300 (1939).—R. studies the continuous warm air driers; other methods and their application and data for calculating industrial

operation are presented. Problems are studied from a practical standpoint. Drying systems are reviewed, and valuable suggestions are given for the special use of each type. Conditions favoring optimum results are also given. M.V.C.

PATENTS

Apparatus for making calcium metaphosphate. H. A. CURTIS AND R. C. HEATON. U. S. 2,173,825, Sept. 26, 1939 (July 23, 1936).

Apparatus for making roofing tile. DAVIS BROWN, J. B. PEEBLES, AND B. M. BURCHFIEL (Davis Brown). U. S. 2,177,607, Oct. 24, 1939 (Aug. 4, 1936).

Apparatus and process for heating air laden with dust. MAVOR AND COULSON, LTD. Fr. 825,453, Aug. 10, 1937. D.A.B.

Automatic cutting apparatus for brick. B. RIVANI. Fr. 849,031, Jan. 17, 1939. D.A.B.

Automatic fuel regulation of open-hearth furnaces. W. C. HOGG AND LEWIS RUMFORD, II (U. S. Steel Corp.). U. S. 2,177,805, Oct. 31, 1939 (July 16, 1935).

Compression press provided with apparatus for deairing ceramic materials. ZIEGELEI OBERBURG A.-G. Fr. 832,-219, Jan. 18, 1938. D.A.B.

Crucible furnace. ISAIAH HALL. U. S. 2,175,462, Oct. 10, 1939 (June 13, 1939).—A tilting furnace includes a supporting structure, a furnace body tiltably mounted on the structure, a crucible mounted in the furnace body and spaced from the walls thereof by a heating chamber for the circulation of the heating gases, a top on the furnace body, and a preheater in the top for preheating the air for the furnace, the preheater extending in the furnace top around the top of the crucible.

Drying and grinding apparatus. MIKAEL VOGEL-JORGENSEN (F. L. Smidth & Co.). Can. 383,725, Aug. 29, 1939 (Nov. 13, 1936). G.M.H.

Drying stoves for pottery, etc. W. BOULTON, LTD., AND E. M. BREEZE. Brit. 513,539, Oct. 25, 1939 (April 12, 1938).

Electronic discharge tubes composed of elements of metallic lining and ceramic lining. C. LORENZ A.-G. Fr. 825,561, Aug. 13, 1937. D.A.B.

Extrusion machines for the manufacture of pottery products. L. POUSSEL. Brit. 512,891, Oct. 11, 1939 (April 8, 1937).

Furnace electrode suspension. JEAN LOUIS LEGERON (Det norske Aktieselskab for Elektrokemisk Industri). Can. 383,238, Aug. 8, 1939 (July 2, 1937). G.M.H.

Gas analyzer. JOHN D. MORGAN AND ALAN P. SULLIVAN (Cities Service Oil Co., Ltd.). Can. 383,553, Aug. 22, 1939 (Dec. 5, 1938). Can. 383,554, Aug. 22, 1939 (Dec. 12, 1938). G.M.H.

Gas detector. G. W. BERNHEIM. Fr. 825,489, Aug. 11, 1937. D.A.B.

Gas mask. F. FRISCH-KNECHT. Fr. 825,704, Aug. 17, 1937. D.A.B.

Means for loading or handling brick. A. GEYER. Brit. 512,935, Oct. 11, 1939 (Feb. 22, 1938).

Melting furnace. E. M. ZIER (R. B. Zier). U. S. 2,178,059, Oct. 31, 1939 (April 13, 1936).—A furnace includes an inner casing constituting a melting chamber, an outer casing spaced from the walls of the inner casing providing an outer steam-generating chamber, the outer chamber being adapted to receive water to submerge the inner casing to protect it, the melting chamber having an inlet and an outlet at the opposite ends thereof extending through the wall of the outer casing, and means for introducing fuel into the melting chamber, the furnace being pivotally supported to be tilted longitudinally and the inner casing being of a form to remain submerged when the furnace is tilted to a substantial degree, the inner casing having a rear section extending at a downward inclination toward the rear end of the outer casing.

Method and apparatus for blunging clay. S. C. LYONS (Bird Machine Co.). U. S. 2,173,975, Sept. 26, 1939 (Feb. 14, 1936).—A method of blunging crude kaolin of intrinsically fine particle size and containing over-sized impurities of the nature of sand and mica comprises streaming such kaolin in the form of an aqueous suspension containing a substantial fraction of palpable aggregates of the ultimate kaolin particles between and out of the sphere of action of relatively moving resilient surfaces clearing each other by such small definite gap and at such high relative speed as is attended by shearing and rubbing action on the aggregates and liberation in the aqueous suspending medium of the ultimate intrinsically fine particles while the oversized impurities are preserved in essentially unreduced size.

Mineral-pulverizing apparatus. CHARLES W. YOUNG AND ALBERT R. WILSON. Can. 383,314, Aug. 8, 1939 (Nov. 17, 1937).—The apparatus comprises a flat abrasive wheel, means for rotating it at high speed, and means for rapidly projecting the material to be ground onto the radial face or faces of the wheel away from its center. G.M.H.

Producing fused products. L. G. BLACK (American Potash & Chemical Corp.). U. S. 2,177,766, Oct. 31, 1939 (May 9, 1936).—A method of producing fused material in particle form comprises subdividing a supply of such granular material into a shower of separated particles as it enters a heating zone, permitting the material to fall through the heating zone and thence through the cooling zone, supplying heat to the particles as they are falling through the heating zone and cooling them while they are passing through the cooling zone, and maintaining a portion at least of the walls of the heating zone under exterior gas pressure sufficient to cause the flow of gas from the walls of the zone into the zone to prevent contact of the falling material with the walls.

Standard for optical pyrometry. R. C. MACHLER (Leeds & Northrup Co.). U. S. 2,176,087, Oct. 17, 1939 (March 16, 1938).

Thermic insulating element. SOC. ANON. DE PRODUITS INDUSTRIELS POUR LA BATIMENT. Fr. 848,968, July 21, 1938. D.A.B.

Tool for drilling ceramic materials. LOUIS POLETIS. U. S. 2,174,389, Sept. 26, 1939 (June 21, 1938).

Tunnel fan. E. L. ANDERSON (American Blower Corp.). Can. 383,211, Aug. 8, 1939 (Feb. 7, 1938; in U. S. Oct. 6, 1937). G.M.H.

Kilns, Furnaces, Fuels, and Combustion

Ceramic firing processes: XII, Steatite. Effect of firing conditions on the elasticity modulus. OTTO KRAUSE AND HSUN-SHAN-CHEN. *Sprechsaal*, **72** [31] 401–402; [32] 411–12 (1939).—Previous experiments on the effect of the firing time, temperature, and furnace atmosphere on the properties of steatite masses of the steatite-clay-feldspar group were completed by measurements of the elasticity modulus. At low firing temperature the elasticity modulus increases with longer firing time. At higher temperatures, the elasticity modulus passes through maximums dependent on firing time and temperature. The increase and decrease of the elasticity modulus are approximately proportional to the logarithms of the duration of firing. A parallel between the elasticity modulus and absolute porosity exists in that a low porosity value "opposes" a higher elasticity modulus. The elasticity modulus so ascertained, however, in no way represents a material constant of ceramic masses but corresponds to the texture of the specimen after firing. The effect of furnace atmosphere on the elasticity modulus could not be determined; a supplementary heat treatment (compensation) increases the elasticity modulus and thus diminishes the elasticity. See "Determining—," *Ceram. Abs.*, **18** [10] 275 (1939); for Parts **VII-XI** see *ibid.*, **17** [2] 81 (1938). M.V.C.

Coal- and gas-fired continuous kilns; adaptability. R. RASCH. *Tonind.-Ztg.*, **63** [12] 127–30 (1939).—Among the advantages of the coal-fired kiln are low initial cost, low operating cost (especially when automatic stokers are

used), easier control of temperature and kiln atmosphere, and lower gas volume and velocity. The main advantage of gas firing is cleanliness inside and outside of the kiln and lower maintenance. A gas-fired chamber kiln is a preferable installation for refractory products because the fire can be regulated better and, at higher temperature, ash and slag are absent. W.K.

Correlation of minable coals of Illinois, Indiana, and western Kentucky. J. MARVIN WELLER AND HAROLD R. WANLESS. *Bull. Amer. Assn. Petroleum Geologists*, **23** [9] 1374–92 (1939).—The numbers by which the principal coals of Illinois, Indiana, and western Kentucky are commonly known are a result of independent work by the geological surveys of these states and, for the most part, do not correspond. Many attempts have been made to correlate the coals within and between states. This is an attempt to correlate the whole basin. Of 50 seams, 6 in Illinois, 5 in western Kentucky, and 8 in Indiana are mined. The most important seam, Harrisburg No. 5 of Illinois, is equivalent to Kentucky No. 9 and Indiana *V*. Herron coal No. 6 of Illinois, the second in importance, is equivalent to Kentucky No. 11. Rock Island coal No. 1 of Illinois is equivalent to the Minshall coal of Indiana and is tentatively suggested as equivalent to the Murphysboro coal No. 2 of Illinois (equivalent to the Mannington coal of Kentucky), the Colchester coal No. 2 of Illinois, and the Danville coal No. 7 of Illinois (equivalent to Indiana *VII*). Coals of restricted importance which are correlated are the lower and upper Brazil blocks of Indiana, coals *III*, *IV*, and *VI* of Indiana, the Grape Creek coal of Illinois, and coals No. 12 and 14 of Kentucky. G.M.H.

Determination of sulfur in solid fuels and pyrites by combustion in the oxygen current. A. SEUTHE. *Glückauf*, **75** [19] 409–11 (1939).—A new method and the apparatus for it are described; this method requires only a 1-g. sample of the material to be analyzed. The determination consists in burning the sample in an electric furnace through which a current of O is passed; the whole S content and also the content of sulfates of the ash go as SO_2 or SO_3 into a H_2O_2 solution in which the H_2SO_4 so formed is titrated with an adjusted solution of NaOH. Exact procedures and measurements for measuring S in coke, coal, and a pyrite are described. M.H.

Effect of firing schedule on quality of glass color decorations. CAMPBELL ROBERTSON AND DANIEL O. KOCH. *Bull. Amer. Ceram. Soc.*, **18** [11] 422–26 (1939).

Firing with gas in brick plants. W. MENDHEIM. *Tonind.-Ztg.*, **63** [19] 212–14; [20] 234–37; [21] 246–48 (1939).—The advantages of firing with producer gas in brick plants are cleanliness, easy control, improvement of the quality of the product, and lower maintenance. Only continuous kilns bring out the economic superiority of gas over coal. The chamber kiln is the type most used; it is constructed in several modifications. The ring kiln has the advantage of a very simple construction. It consumes less fuel than the chamber kiln. For firing ordinary brick, gas is not economical, but for higher temperatures it is advantageous. Tunnel kilns are being used more and more for heavy clay products. The main advantage is the easy regulation of temperature and atmosphere. The purification of the producer gas is beneficial. City gas has a higher heat value and a hotter and shorter flame and is therefore less adapted to ceramic firing. It may be useful for periodic kilns. W.K.

Gauze filters for fuel oil. JOHN CONWAY. *Eng. & Boiler House Rev.*, **53** [2] 118 (1939).—C. describes some of the fundamental factors governing the use of filters for removing foreign material from fuel oil. A combination of coarse and fine mesh filters was most satisfactory. Ordinary weave or twilled weave gauze is preferable to either corduroy or hollander weave wire fabrics due to the greater ease with which they may be cleaned. Warming viscous oils increases their filtering rate. B.C.R.

Graphical determination of heat transmission through a wall. JEAN SZCZENIOWSKI. *Chaleur & Ind.*, **20** [232] 491–94 (1939).—The quantity of heat transmitted from a hot medium (A) through a wall (C) to a cooler medium (B) is given by the following equation:

$$Q = \frac{(T - \theta)}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{\alpha_1 + \alpha_2}},$$

where Q = heat transmitted in cal., T = temperature of A in °C, θ = temperature of B in °C, K_1 = coefficient of transmission A to C, K_2 = coefficient of transmission of C, α_1 = coefficient of transmission C to B by convection, and α_2 = coefficient of transmission C to B by radiation; α_1 and α_2 are determined by $\alpha_1 = A(t - \theta)^{1/4}$;

$$\alpha_2 = C \times \frac{\left(\frac{t + 273}{100}\right)^4 - \left(\frac{\theta + 273}{100}\right)^4}{(t - \theta)},$$

where t = temperature of the cooler surface of the wall, A = constant depending on the form of the wall surface, and C = constant depending on the nature of the wall surface. The value of t is found by the method of successive approximations. From these equations, S. presents a series of curves which may be used to read directly the relations between these terms. The methods of graphical solution of various problems are outlined. V.D.F.

Hard pitch as a fuel. J. DAVIS. *Edgar Allen News*, **18** [209] 450 (1939).—Hard pitch is being used in pulverized form as fuel; its calorific value is about 16,000 B.t.u. per lb., it is low in S, and it has an ash content of less than 0.5%. It is easily adapted to automatic firing and at present is used especially in plate heating, forging, and billet heating furnaces and in boilers. It can replace oil firing with substantial economies and better thermal efficiency. A layout for an equipment for pulverizing and firing pitch is described. M.H.

Laboratory equipment for instruction in thermal decomposition. W. L. FAITH AND J. E. HEDRICK. *Trans. Amer. Inst. Chem. Engrs.*, **34**, 21–29 (1938).—A laboratory experiment in thermal decomposition or pyrolysis is outlined. The laboratory work is divided into two parts, one dealing with the thermal decomposition of solids and the other with liquids. A satisfactory laboratory apparatus is described. Typical results are presented for the pyrolysis of coal, wood, and petroleum. H.E.S.

Measurements of thermal diffusion in gas mixtures. G. BLÜH, O. BLÜH, AND M. PUSCHNER. *Phil. Mag.*, **24**, 1103–14 (1937).—The object of these experiments was to observe continuously the process of thermal diffusion in a gaseous mixture till the separation had reached a state of equilibrium. For this purpose an interferometer was devised, and the thermal diffusion of the following gas mixtures was determined: hydrogen-carbon dioxide, hydrogen-nitrogen, helium-argon, and helium-neon. From the results, which were in agreement with those obtained by T. L. Ibbs, the values of the indices of repulsive force of the molecules were calculated according to Chapman's theory. R.H.

Mechanical stokerization of refractory firing kilns. H. M. CHRISTMAN. *Bull. Amer. Ceram. Soc.*, **18** [10] 369–70 (1939).

Pottery firing. ANON. *Pottery & Glass Record*, **21** [8] 202 (1939).—In Stoke-on-Trent, the chief center of the potteries in England, 13 more kilns heated exclusively by town gas have been installed during the year, making a total of 66 kilns, half of which are used for tile. A biscuit-firing tunnel oven recently erected, the first in the district for its particular purpose, and the first gas-fired decorating kiln are both giving good results. Four electrically heated kilns have also been connected to the public electric supply, making 24 of such kilns; all of these are enamel decorating kilns with the exception of one which is a glost kiln; the latter is the first to be connected to the supply. A.B.S.

Report of the Ceramic Industries Committee. O. L. MADDUX. *Amer. Gas Assn. Proc.*, **20**, 547–52 (1938).—Gas burning equipment installations in the ceramic industry numbered 57 during the past year, 44 using natural gas, 4 mixed gas, and 9 manufactured gas. Data reported for 31 of these show approximate annual consumptions as

follows: manufactured gas, 85,600 million cu. ft.; mixed gas, 25,500 million cu. ft.; and natural gas, 505,300 million cu. ft. The report includes a list of the installations. Illustrated. S.S.

Self-closing safety covers on brickwork flues for producer gas on kilns. ONNI DAHL. *Tonind.-Ztg.*, **63** [16] 176–78 (1939).—To minimize the danger and damage from explosions, brickwork flues for producer gas should, at regular intervals, have safety covers which open to relieve the pressure and shut again immediately to prevent the entrance of air. Directions for the installation of such safety valves are given. W.K.

Symposium on importance of thermal history: I, Problems of firing ceramic ware in tunnel kilns. PHILIP DRESSLER. *Bull. Amer. Ceram. Soc.*, **18** [11] 411–16 (1939). **II, Thermal history of the glassy phase and its effect upon physical properties.** WOLDEMAR A. WEYL. *Ibid.*, pp. 416–19. **III, Effect of thermal history on the physical properties of electrical porcelain.** E. H. FRITZ AND H. C. HARRISON. *Ibid.*, pp. 420–21.

Thermal insulation in the heavy clay industry. J. S. F. GARD. *Brit. Clayworker*, **48** [568] 174–79 (1939).—G. discusses the value of insulation of furnaces and kilns. Illustrations are given of the savings effected under different conditions of temperature and thickness of insulation. R.A.H.

Thermal insulation of structures by air: I. G. FIESTÉ. *Chaleur & Ind.*, **20** [231] 439–45 (1939).—While insulation of continuous furnaces by the use of thick walls may be economical for continuous furnaces, the heat used in heating up thick walls in a periodic furnace is considerable. For such cases and for accurate calorimetry, insulation by air is indispensable. By consideration of the separate factors, radiation, convection, and conduction, F. develops the value of transmission of heat between two surfaces across an air space: $Q = \frac{\lambda_{cc} + \lambda_r}{e} (\theta_1 - \theta_2) \times S$, where Q = heat transmitted in Cal., λ_{cc} = coefficient of transmission by convection and conduction (expressed in Cal./m. hr. °C), λ_r = coefficient of transmission by radiation (expressed in Cal./m. hr. °C), θ_1 = temperature of warmer surface in °C, θ_2 = temperature of cooler surface in °C, S = area of the air interval parallel to the boundary surfaces in sq. m., and e = thickness of the air gap. Nomographs are given from which may be read the values of the various constants under any given conditions, including temperature difference between the walls, mean temperature of the air space, thickness of the space, radiation properties of the walls, and barometric pressure, for both horizontal and vertical walls. A single chart links all these so that a continuous operation gives a graphical solution. **II.** *Ibid.*, [232] 495–500.—Consideration of examples shows that the insulation value of an air interval depends very much on the mean temperature of the air, being much better at lower temperatures. At high temperatures, the insulation value is almost independent of the dimensions of the interval and depends almost entirely on the temperature difference between the faces. A thickness of 5 cm., in general, is found to be optimum. The radiation constant of the faces is of paramount importance, a bright surface being advantageous. Radiation constants are listed for several materials. In disagreement with other workers, F. finds that the height of the air space does not affect its insulating value, but he recommends horizontal partitioning of high air spaces to localize any defects in the walls. Intermittent operation in furnaces decreases the insulation value of air spaces at low temperatures and increases it at the maximum temperatures because of the thermal lag of the air space. Air intervals are most effective when placed in the wall remote from the hot face, but they are also desirable near the hot face, especially in periodic installations. The effect of moisture in the air gap and the necessity for ventilation to remove it are reviewed. The use of light, porous materials in the air space is valuable in suppressing convection currents. Results for a variety of such materials are listed. V.D.F.

PATENTS

Balanced draft and flash wall for kilns. L. R. ROBINSON (United Combustion Corp.). U. S. 2,173,614, Sept. 19, 1939 (May 7, 1936).

Kilns and driers. E. ALLEN & CO., LTD., AND H. ANDREWS. Brit. 513,469, Oct. 25, 1939 (March 7, 1938).

Tunnel kiln. J. J. DURIEUX. U. S. 2,180,041, Nov. 14, 1939 (July 2, 1935).—A horizontal tunnel kiln comprises, in combination, a burning zone, a plurality of burners arranged in a horizontal longitudinal row in the zone, collective air-feed means for the burners in the zone, individual air-feed means leading from the collective means to each burner, and a cooling zone having at least one horizontal passage provided in its wall, the passage opening directly into the atmosphere at one end of the kiln and into the collective air-feed means at the other end.

Geology

Acidity of quartz. G. VAN PRAAGH. *Nature*, **143** [3634] 1068 (1939).—P. finds that quartz dust which has been heated to 300°C *in vacuo* until the evolution of gas ceased does not affect the pH of neutral water. He suggests that the acidity usually produced is due to solution of CO_2 which has been adsorbed on the quartz particles. J.L.G.

Andesite lava of the French Central Massive. V. CHARRIN. *Argile*, No. 197, pp. 1–5 (1939).—The geological formation and characteristics of the lava deposits of the Volvic valley and Mont-Dore zone are described. M.V.C.

Beneficiation of Alabama glass sands. R. F. HAVELL AND T. N. MCVAY. *Bull. Amer. Ceram. Soc.*, **18** [11] 429–31 (1939).

Bentonite from the Leitha limestone of Fertörákos. MIKLOS VENDL. *Földtani Közlöny*, **68**, 89–102 (1939); abstracted in *Chem. Zentr.*, **1939, II**, 1254.—Bentonite deposits and their geology are discussed. The principal constituent is montmorillonite, with admixtures of quartz, sanidine, oligoclase, zircon, limonite, ilmenite, calcite, and muscovite. See "Recent—," *Ceram. Abs.*, **17** [5] 198 (1938). M.V.C.

Chemical investigation of silicates: VIII, Thermal transformation of anthophyllite, $Mg_7Si_8O_{22}(OH)_2$; polymorphism of magnesium metasilicate and mechanism of transformation of anthophyllite and talc upon heating. ERICH THILO AND GERHARD ROGGE. *Ber. Deut. Chem. Ges.*, **72B**, 341–62 (1939).—Anthophyllite, heated to 900°C, gives off its water, liberates a molecule of SiO_2, and is converted into enstatite: $Mg_7Si_8O_{22}(OH)_2 \longrightarrow 7MgSiO_3 + SiO_2 + H_2O$. When the temperature reaches 1050°C the enstatite changes into $MgSiO_3$ (discovered by Haraldsen) for which the name mesoenstatite is recommended. Anthophyllite is directly converted into enstatite. Talc, $Mg_3SiO_4O_{10}(OH)_2$, heated to 900°C, is at first decomposed into MgO and SiO_2 (and H_2O). With prolonged heating at 900°C a $MgSiO_3$ modification given as M_1 and one given as M_2 at 1020°C are formed. Above 1250°C these change into mesoenstatite. Magnesium salts, precipitated with Na_2SiO_3 and CO_2 to form $MgSiO_3$, behave in a similar way. The three $MgSiO_3$ modifications, enstatite, mesoenstatite, and clinoenstatite, are stable enantiotropic modifications of magnesium metasilicate. Enstatite is stable up to 900°C, mesoenstatite is stable between 900° and 1270°C, and the clinoenstatite is stable above 1270°C. The mechanism of transformation of talc and anthophyllite is discussed upon the basis of their crystal structure. A series of Debye exposures and 7 tables are presented. For Parts VI–VII see *Ceram. Abs.*, **17** [6] 232 (1938). L.E.T.

Chrome mining in Southern Rhodesia. J. MUSGRAVE. *Bull. Inst. Mining & Met.*, No. 410, pp. 1–16 (1938).—Foremost among the Rhodesian chrome deposits are those

in the Selukwe district where at present three mines are being worked for chrome ore. The composition appears to be nearer picotite than chromite and may be considered to fall under the variety chromopicotite. Chromic oxide found in the ore ranges from 40.10 to 54.27%, and a typical analysis is as follows: Cr_2O_3 51.1, FeO 11.4, Fe_2O_3 1.4, MnO 0.5, Al_2O_3 15.2, MgO 12.7, CaO 0.9, P_2O_5 0.5, SiO_2 4.8, H_2O, etc., 1.9%. Occasionally magnetite is present in the free state and is eliminated by magnetic separation. R.H.

Coloring different synthetic silicates by "chromophor" nickel. D. P. Grigor'ev. *Zapiski Vserossiiskogo Mineral. Obshchestva*, **67** [1] 63–66 (1938); abstracted in *Chem. Zentr.*, **1939, II**, 1455.—Synthetic forsterite containing up to 4.88% Ni, enstatite containing up to 4.74% Ni, and amphiboles (of the tremolite type) containing up to 4.94% Ni were obtained. The melting was done at 1500° with an addition of 2 to 4% boric acid. Orthosilicates were green; silicates with a chain structure were yellow. M.V.C.

Composition of clays. Carl W. Correns. *Umschau*, **43** [34] 787–89 (1939). J.M.N.

Effect of carbon dioxide pressure upon equilibrium of the system hydrogen colloidal clay–water–calcium carbonate. F. Simmons. *Jour. Amer. Soc. Agron.*, **31** [7] 638–48 (1938).—S. found that the equilibrium in the clay–$CaCO_3$–H_2O–CO_2 system can be established within 12 to 15 hr. when $Ca(OH)_2$ or CaO is used as a source of Ca. The CO_2 pressure affects the absorption of calcium by a hydrogen clay. Increase in CO_2 pressure increases the relative concentration of hydrogen ions more than the calcium ion concentration. It is shown that over the lower CO_2 pressures, the change in calcium absorption is a linear function of the cube root of the CO_2 pressure expressed in atmospheres. R.K.

Effect of iron on physicochemical properties of bentonite suspensions. J. F. Lutz. *Soil Sci. Soc. Amer., Proc.*, **3**, 7 (1938).—Electrodialyzed bentonite suspensions were treated with $FeCl_3$ in quantities from 12.5 to 250% of the adsorption capacity and washed with water until no Cl^- appeared in the washings. An increase in Fe adsorption was accompanied by an increase in Cl^- adsorption. Swelling of the colloid was very nearly proportional to the Cl/Fe ratio. The Fe-bentonite suspensions with the higher amounts of iron were no redder than those with smaller amounts. R.K.

Fluorescent ion of chromium in ruby. B. V. Thosar. *Phil. Mag.*, **26** [175] 380–89; [178] 878–87 (1938).—The hard refractory precious stone, ruby, which is composed of corundum with a small percentage of chromium as impurity, fluoresces with a bright red color when excited with light of shorter wave lengths. Previous investigators have stated that it is the chromium ion which causes fluorescence. T.'s explanation of the phenomenon is that the fluorescent ions of chromium enter the crystal lattice of Al_2O_3, replacing the corresponding Al ions of the corundum lattice. R.H.

Gelation and film formation of colloidal clays. E. A. Hauser and D. S. Le Beau. *Jour. Phys. Chem.*, **42**, 961 (1938).—Various theories of gelation are discussed in connection with ultramicroscopic studies of the gelation of extremely dilute colloidal clay sols. The formation of coherent colloidal clay films of high flexibility has been observed and is receiving further study. X-ray and infrared absorption diagrams are given. In addition to regular Brownian motion, a peculiar rocketlike movement of particles has been observed in extremely fine bentonite fractions. R.A.G.

Geology of kaolin and refractory clay deposits of the Ussolskii region (Irkutsk Province). M. M. Odintsov. *Sovet. Geol.*, **8** [11] 83–91 (1938); abstracted in *Chem. Zentr.*, **1939, II**, 612.—Kaolins found contain from 56 to 80 SiO_2, 0.1 to 2.0 Fe_2O_3, 12 to 30 Al_2O_3, 0.3 to 1.03 TiO_2, < 2.0 CaO + MgO, < 4.1 K_2O + Na_2O, and 0.1 to 0.4% SO_4. M.V.C.

Geophysical consolidation problems. H. Löwy. *Phil. Mag.*, **27** [184] 576–78 (1939).—The theory of Terzaghi is confirmed according to which the settlement, *s*, of a clay layer of the initial thickness, *h*, is equal to the height of the column of water pressed out per unit of surface. L. regards clay containing water in its pores as a mixture of electrically conductive particles (water) dispersed in an insulating substance (clay). A formula for the electrodynamic determination of clay is given. The pore number, the water volume contained in 1 cc. of clay, the ratio *s*/*h*, and the dielectric constant of the clay-water mixture are calculated for eight American clay substances. The dielectric constant of dry sand increases from 3.7 to 6.1 for a density change from 1.03 to 1.34. R.H.

Inorganic giant molecules. Hermann M. Rauen. *Umschau*, **43** [14] 318–20 (1939).—Structure diagrams are shown and described and chemical formulas are given for several natural silicates. J.M.N.

Intrusion temperature of peridotites. Robert B. Sosman. *Amer. Jour. Sci.*, **35A**, 353–59 (1938).—Experiments in heating a coke inclusion from a peridotite dike in Fayette County, Pa., and chemical analysis of the same inclusion for hydrogen, oxygen, and nitrogen agree in indicating that the maximum temperature reached by the coke was between 440° and 520°C. The intrusion temperature of the peridotite could therefore hardly have exceeded 600°C. How a rock of this composition could have been intruded at so low a temperature remains to be determined. J.B.A.

Length changes and endothermic and exothermic effects during heating of flint and aluminous clays. Raymond A. Heindl and Lewis E. Mong. *Jour. Research Nat. Bur. Standards*, **23** [3] 427–42 (1939); R.P. 1243. Price 5¢.—A study was made of the changes in length and endothermic and exothermic effects between room temperature and 1000°C in 9 flint clays, 3 kaolins, and 1 each of a diaspore and a plastic clay. Their pyrometric cone equivalents were also determined and some microscopic examinations were made. All the flint clays (except one mined in Pennsylvania), as well as the Georgia and Zettlitz kaolins, showed (1) a slight expansion between room temperature and approximately 500° and 600°C, (2) a gradual contraction between 600° and 925°C, (3) a rapid contraction between approximately 925° and 980°C, and (4) a slower contraction again from 980° to 1000°C. The Pennsylvania (Dean) flint, which was one of the exceptions in the unpulverized condition, showed a sharp expansion between about 540° and 590°C, but when pulverized through a No. 200 sieve it acted similarly to the other flint clays. In general, the pulverized clays showed greater total shrinkage up to 1000°C than the unpulverized clays. The ranges in temperature in which rapid contraction took place were slightly lower for the fines than for the coarse material. The Missouri flint clay showed no differences in these ranges when the two types of specimens were prepared from adjacent material. Much variation in the magnitude of the rapid contraction during heating occurred in specimens prepared from different lumps of a sample of flint clay as well as from the same lump. The nonuniformity of the clays could readily be determined by visual examination. The one plastic refractory clay tested showed very little contraction in the 500° to 900°C range, but between 900° and 1000°C it showed approximately the same contraction as that shown by some of the flint clays. Most of the clays showed slightly greater contraction in an atmosphere of the products of gas combustion than in air. Endothermic reactions took place between 475° and 575°C, and exothermic reactions took place between 940° and 990°C in all the flint clays, the plastic clay, and the Georgia kaolin. The temperature ranges during which these reactions occurred corresponded fairly closely to those in which rapid contraction took place. The bauxitic Georgia kaolin contracted rapidly during two ranges of temperature, viz., approximately 480° to 540°C and 970° to 990°C. A slight inflection or temporary reversal in trend from expansion to contraction to expansion was also indicated between 250° and 310°C. A pronounced endothermic effect was observed at the lower range of temperature and a moderately large one was observed within the intermediate range. An exothermic effect was observed within the highest range. The oölites from the bauxitic

Georgia kaolin showed fairly pronounced contraction during three ranges of temperature, viz., approximately 250° to 310°C, 480° to 560°C, and 970° to 990°C. An unusually large endothermic effect was observed at the lower range and a rather small one was observed at the intermediate range. The exothermic effect, which reached its maximum at 980°C, was small. Diaspore showed contraction during one stage only, between 450° and 510°C, and but one heat effect, an endothermic one between 450° and 510°C. R.A.H.

Luminescence phenomena in the mineral realm. M. DÉRIBÉRÉ. *Ann. Chim. Anal. Chim. Appl.*, **21** [5] 119–23; [6] 145–52 (1939).—Luminescence is a characteristic property possessed by certain bodies of emitting light, regardless of ordinary reflection and thermal incandescence; such bodies must be first activated, and the energy imparted to them is more or less completely transformed into luminous radiation. Activation may be produced by internal chemical forces, by a biological process, by mechanical action, by crystallization, by sudden chilling, by heating up, or by irradiation; the latter process of activation is termed photoluminescence. This itself is a general phenomenon since the source of external radiation may vary widely (X rays, ultraviolet radiation, etc.). Photoluminescence gives rise to two distinct aspects: (1) fluorescence, i.e., absorption of energy and nearly instantaneous emission of the absorbed radiations in longer wave length according to Stokes' law, and (2) phosphorescence, a transformation similar to that in 1 except that irradiated energy is first stored in the body and then released little by little after irradiation has ceased. Such a discrimination is, however, not quite satisfactory since fluorescence is not absolutely instantaneous, and physicists have introduced the following differentiation: fluorescence is not influenced by temperature variations, while phosphorescence increases with a rise of temperature. Photoluminescence has made great advances; Wood succeeded in preparing filtering screens permitting the selection of definite wave lengths, i.e., the separation of ultraviolet radiations from the visible spectrum. D. describes the procedure adopted for his investigations and gives the results of observations made on all kinds of minerals. Neither silica nor its colored varieties (amethyst, aventurine, rose quartz) are fluorescent, but hydrated siliceous concretions may show fluorescence (opal, hyalite, chalcedony). Fluorescence is exceptional in alkaline silicates, but in some varieties it is sometimes remarkable and characteristic. Several feldspathoids (nepheline, leucite, sodalite) exhibit fluorescence, which permits their detection in the rock by naked eye or with the microscope, especially if irradiated with ultraviolet light. In complex aluminosilicates containing multiple alkaline bases, e.g., scapolite, fluorescence is frequent (Canadian wernerite shows a yellow fluorescence and even a green thermoluminescence). Feldspars, gneiss, mica schist, and feldspathic granite are not fluorescent. Experiments carried out on a great number of mineral species show that rocks of the crystalline schist type exhibit thermoluminescence, while eruptive rocks do not. The following minerals are dealt with: limestones, gypsum, phosphates, natural alkaline salts, fluorite, rare earths, precious gems, hydrocarbons, and fossil gums. See "Thermoluminescent—," *Ceram. Abs.*, **18** [4] 113 (1939). R.W.D.

Manganese of Labinsk and its industrial production. N. E. EFREMOV. *Sovet. Geol.*, **8** [12] 66–76 (1938); abstracted in *Chem. Zentr.*, **1939, II,** 613.—The ore contains from 6 to 34% Mn, 30 to 78% SiO_2, and smaller quantities of Al_2O_3 (up to 9%), Cr_2O_3, Fe_2O_3, CaO, MgO, NiO, and P_2O_5. M.V.C.

Methods for clay analysis. M. MEHMEL. *Zement*, **28** [4] 45–49; [5] 59–64; [6] 75–80 (1939).—The particle-size determination and the optical and X-ray methods, though essential, are only a complement of the chemical analysis. The former "clay substance" is a mixture of minerals in variable proportions. Its composition changes in different points of a given layer. This faulty expression should be avoided in the future. See "Optical—," *Ceram. Abs.*, **18** [7] 194 (1939). F.E.V.

Mineralogical subdivisions of soil separates. R. W. PEARSON AND E. TRUOG. *Soil Sci. Soc. Amer., Proc.*, **3**, 20 (1938).—Specific gravity separations were performed on several soils and crude nontronite by means of heavy liquids. In the case of the coarse clay separate, feldspar and quartz were found only in the specific-gravity fraction 2.15 to 2.72. The fraction 3.00 contained practically all of the talc and biotite. The bulk of the base-exchange material was found in the specific-gravity fraction 2.18 to 2.33. R.K.

Modified logarithmic probability graph for the interpretation of mechanical analyses of sediments. GEORGE H. OTTO. *Jour. Sed. Petrology*, **9** [2] 62–76 (1939). G.M.H.

Nature and properties of clays in the soil. ALBERTO MALQUORI. *Ricerca Sci.*, **10** [3] 130–47 (1939).—M. reviews the results obtained with X-ray analysis in studying the nature and properties of clay minerals in soils. 62 references. V.S.M.

Neutral carbonate and basic carbonates of beryllium. G. VENTURELLO. *Gazz. Chim. Ital.*, **69** [2] 73–86 (1939).—The preparation of basic carbonates from Be_2O_3 is described; two salts were obtained, $7Be(OH)_2 \cdot 2CO_2 \cdot mH_2O$ and $3Be(OH)_2 \cdot CO_2 \cdot nH_2O$. They have no distinctive characteristics by which they can be defined as definite compounds. The neutral carbonate was examined roentgenographically; its composition corresponds to $BeCO_3 \cdot 4H_2O$ and it crystallizes in the hexagonal system with $a = 5.12$ Å, $c = 15.77$ Å. 35 references. M.H.

New processes in clay technology. ANON. *Chem. Age* [London], **41** [1049] 102 (1939).—Pure bentonite gel containing a suitable proportion of water can be dried in such a manner that the product becomes transparent and resembles mica. It is used for making fireproof packages and as an impermeable coating for paper. A.B.S

Pegmatite; ceramic rock. V. CHARRIN. *Verre & Silicates Ind.*, **10** [22] 260–61 (1939).—The present tendency of ceramic manufacturers to use, as raw material, composite rock containing elements formerly obtained from several materials is seen in the growing importance of pegmatite, which is essentially a quartz feldspar with impurities. Pegmatites, formerly, were sometimes confused with feldspars. The rational exploitation of pegmatite deposits in France, which are listed, would do away with the necessity of importing it and, in addition, would furnish a source of profit from the incidental minerals also derived from it. See *Ceram. Abs.*, **17** [8] 289 (1938). M.V.C.

Phosphates of Quercy, France. DEM. *Argile*, No. 197, pp. 5–9 (1939).—Extracts are given from the detailed study of Bernard Gèze on the phosphates of Quercy, their formation, description, and the hypothesis of their origin. M.V.C.

Raw materials of sanitary ceramics. HANS LEHMANN. *Umschau*, **42** [52] 1205–1206 (1938). J.M.N.

Relationship between chemical composition and structure of clay minerals. W. F. BRADLEY. *Trans. Illinois State Acad. Sci.*, **31** [2] 130 (1938).—B. suggests the use of two classifications into which the common clay minerals may be placed. In clays in which some of the Si^{++++} has been replaced by Al^{+++}, the resulting material will have stable lattice dimensions, moderate plasticity, and moderate base-exchange capacity; whereas, in clays in which a replacement of Al^{+++} by Mg^{++} or Fe^{++} has predominated, the clays will swell on the addition of water, disperse readily to extremely small particle size, and exhibit high base-exchange capacity. B.C.R.

Secondary quartzites and their relationship with other rocks. N. I. NAKOVNIK. *Sovet. Geol.*, **8** [11] 42–54 (1938); abstracted in *Chem. Zentr.*, **1939, II,** 612.—Angellite, ilmenite, and lazurite are constituents of secondary quartzite of the Altai Mountains. The formation order of quartz minerals in the pneumatolytic and hydrothermal phases is rutile, ilmenite, hematite, quartz, andalusite, topaz, muscovite, zunyite, tourmaline, dumortierite, lazurite, angellite, pyrite, corundum, diaspore, cerussite, chlorite, kaolinite, "alaunstein," and barite and, in the surface layers, jarosite, limonite, and kaolinite. M.V.C.

Solubility of quartz and flint after the action of water or soda solution under pressure. J. A. HEDVALL AND O. WEILER. *Z. Anorg. & Allgem. Chem.*, **239** [3] 295–300 (1938).—Quartz and flint of four different grain sizes were treated with 5, 10, and 20% soda solutions at pressures of 2, 5, and 10 atm. The solubility increases with an increase in temperature and duration of the treatment and with increasing fineness. Flint is more soluble than quartz. A treatment of 8 hr. at 10 atm. with water gave only slight reaction. W.K.

Theory of montmorillonite. J. DE LAPPARENT. *Compt. Rend.*, **209** [5] 279–81 (1939).—For physicochemical reasons it is considered wrong to ascribe to montmorillonite the formula of pyrophyllite plus water, i.e., $H_2O \cdot Al_2O_3 \cdot 4SiO_2 + nH_2O$. The correct formula is $H_2O \cdot Al_2O_3 \cdot MgO \cdot 5SiO_2 + nH_2O$. This is derived from analyses made with pure Algerian bentonites. Montmorillonite is considered to be a phyllite with a thickness of the elementary lamella higher than 10 Å. M.H.

Thermal dissociation of diaspore clay. PAUL G. HEROLD AND C. M. DODD. *Jour. Amer. Ceram. Soc.*, **22** [11] 388–91 (1939).

Variations in composition of feldspar from a soil profile. C. D. JEFFERIES AND J. W. WHITE. *Soil Sci. Soc. Amer., Proc.*, **3**, 26 (1938).—Data are presented showing the occurrence and chemical composition of the feldspar of the very fine separates of eight horizons of a virgin soil profile. On chemical analysis, the orthoclase appears to be kaolinized and disappears. The microcline is not weathered to any appreciable extent. Microchemical tests seem to show that the surface of the microcline is coated with a material similar to plagioclase. R.K.

Vermiculite. C. C. DOWNIE. *Chem. Age* [London], **41** [1052] 143–44 (1939).—Vermiculite was not mined commercially before 1930, but it is now widely used, chiefly as a sound- and heat-insulating material. The chief occurrences are in the United States (sales there in 1937 amounted to 24,556 tons), Austria, Russia, and Transvaal. It is a hydrated chlorite, containing 38 to 45 silica, 5 to 9 alumina, and 2 to 7% potash, related to apatite (mica) but richer in alkali. The color ranges from white through brown to black. The material can be scratched by the fingernail. Prior to use it must be calcined at 900° to 1000°C, when it exfoliates greatly in bulk and weighs 3½ to 4 lb. per cu. ft.; an inferior grade weighs about 14 lb. per cu. ft. Overfiring or underfiring and very slow cooling destroy its value. Its melting point is 1350°C and its sintering point is 1240°C. A.B.S.

BOOKS AND SEPARATE PUBLICATIONS

Essential Minerals for National Defense. ANON. *Mining & Met. Soc. Amer. Bull.*, No. 250, 38 pp. (1939).—A resolution addressed to the government of the U. S. lists and tabulates minerals of strategic importance. Those which do not exist or are immaterial in quantity in the United States are Sb, asbestos, Cr, Co, cryolite, diamonds, graphite, He, Mn, Hg, mica, Ni, Sn, W, and Zr. Those which exist in scanty supply which may be stimulated by higher prices are bauxite, Br, Cb, graphite, I, Hg, Pt, Ra, Ti, W, U, V, and Ta. Minerals requiring higher prices to increase production although existing in abundance are asbestos, fluorspar, Pb, mica, P, K, and Zn. A.G.S.

Feldspar. ROBERT W. METCALF. Preprint from Bur. Mines Minerals Yearbook, 1939. 11 pp. Price 5¢. R.A.H.

Introduction to Crystal Chemistry. R. C. EVANS. Macmillan Co., New York. 388 pp. Price $4.50. Reviewed in *Science News Letter*, **36** [10] 160 (1939).—The discovery of the diffraction of X rays by the atomic gratings formed in crystals has now produced a sufficiently large amount of knowledge to make feasible a compilation of the chemical and physical properties which can be obtained by this method. This knowledge is brought together in a valuable book. P.G.H.

Marketing Talc, Pyrophyllite, and Ground Soapstone. BERTRAND L. JOHNSON. *U. S. Bur. Mines Information Circ.*, No. 7080. 13 pp. Free.—J. defines these minerals and describes the properties that make them valuable commercially. Data on the uses, occurrence, production, sales, and markets are included. R.A.H.

Minerals Yearbook, 1939. U. S. BUREAU OF MINES. Supt. of Documents, Govt. Printing Office, Washington, D. C. 1447 pp. Price $2.00. A complete economic and statistical summary of the mineral industry of the United States in 1938 is given. This edition contains a larger amount of precise and detailed data than any previous edition. R.A.H.

Minor nonmetals: carbon dioxide; graphite, greensand; kyanite, andalusite, and dumortierite; lithium minerals; meerschaum; mineral wool; monazite; olivine; serpentine; strontium minerals; topaz; and vermiculite. PAUL M. TYLER. Preprint from Bur. Mines Minerals Yearbook, 1939. 14 pp. Price 5¢. R.A.H.

Nature of Chemical Bond and Structure of Molecules and Crystals. LINUS PAULING. Cornell Univ. Press. 429 pp. Price $4.50. Reviewed in *Science News Letter*, **36** [2] 32 (1939).—Molecular structure from the quantum mechanical point of view with special emphasis on the new concept of molecular resonance is discussed. No knowledge of quantum mechanics or higher mathematics on the part of the reader is assumed since the book is the outgrowth of P.'s Baker Lectures at Cornell University and his courses at California Institute of Technology. P.G.H.

Talc, Pyrophyllite, and Ground Soapstone. BERTRAND L. JOHNSON AND K. G. WARNER. Preprint from Bur. Mines Minerals Yearbook, 1939. 8 pp. Price 5¢. R.A.H.

Vermiculite Deposits in Palaboroa Area, Northeast Transvaal. C. M. SCHWELLNUS. *Union S. Africa, Dept. Mines, Geol. Series Bull.*, No. 11, 27 pp. (1938).—Vermiculite deposits occur in the pyroxenites and serpentinous rocks in large quantities. Examination of seven typical samples indicates that they are equal in quality to good American vermiculite. The exfoliated vermiculite as tested weighs 3.8 to 9.9 lb./cu. ft. for $-\frac{1}{2}$ in. to $+\frac{1}{4}$ in. size. Thermal conductivity is 0.42 to 0.48 B.t.u./sq. ft. hr. °F in. The sintering temperature is 1230° to 1280°C, and the melting temperature is 1280° to 1350°. Average analysis shows SiO_2 44.3, TiO_2 1.3, Al_2O_3 6.6, Fe_2O_3 7.6, FeO 2.0, MnO 1.0, MgO 21.9, CaO 3.2, Na_2O 0.7, K_2O 2.3, H_2O combined 3.4, H_2O moisture 3.3, P_2O_5 0.8, and CO_2 1.2%. A.G.S.

PATENTS

Drilling mud. ALLEN D. GARRISON (Texaco Development Corp.). Can. 383,458, Aug. 15, 1939 (March 9, 1938; in U. S. April 8, 1937). Can. 383,459, Aug. 15, 1939 (Aug. 5, 1938; in U. S. Aug. 25, 1937). G.M.H.

Fluorescent material and a fluorescent element incorporating it. CARL PFANSTIEHL (Pfanstiehl Chemical Co.). U. S. 2,176,100, Oct. 17, 1939 (Nov. 23, 1938).—A fluorescent powder comprises zinc beryllium silicate in the form of unground crystals substantially all less than two microns in size and a pair of activators, one of the activators being a rare earth metal.

Fluorescent material and method of preparing. CARL PFANSTIEHL (Pfanstiehl Chemical Co.). U. S. 2,176,099, Oct. 17, 1939 (Feb. 16, 1938).—A loose flocculent fluorescent material in the form of individual unground crystals, substantially all of which are of the order of one micron in size.

Obtaining uranium and vanadium from their ores. R. D. NYE AND D. J. DEMOREST (Utah Alloy Ores, Inc.) U. S. 2,173,523, Sept. 19, 1939 (June 5, 1936).

Zeolite preparation. MILTON J SHOEMAKER (C. F. Burgess Laboratories, Inc.). Can. 383,118, Aug. 1, 1939 (Aug. 30, 1937; in U. S. Sept. 30, 1936). G.M.H.

Chemistry and Physics

Basic-slag analysis. G. A. GRIZZELL. *Chem. Trade Jour.*, **104**, 522 (1939).—A modified method for total phosphate in basic slag reduces the time for filtering off insoluble SiO_2 from 3 hr. to $^1/_2$ hr. Instead of evaporating the sample of basic slag to dryness with HCl (3 hr.), NH_4Cl amounting to twice the weight of the slag is first added to the slag, which is then boiled with HCl and digested on a water bath for $^1/_2$ hr.; the SiO_2 is then filtered. Citric acid (ten times the weight of slag), followed by magnesia mixture, is added to the filtrate. On cooling, 0.880 ammonia is added and the whole is stirred 1 hr. The precipitate is filtered, ignited, and weighed as magnesium pyrophosphate. Tests show agreement to 0.10% P_2O_5 by both methods. L.R.B.

Calcium silicophosphate. G. NAGELSCHMIDT. *Jour. Chem. Soc.* [London], **1937**, pp. 865–66.—A new compound with a chemical composition approximating $7CaO, P_2O_5, 2SiO_2$ has been isolated from certain medium-soluble open-hearth basic slags. It has d^{20} 3.035, η_γ 1.661, and η_α 1.652 for sodium light and is colorless and biaxial positive with a very small axial angle. X-ray powder data are given. This material is almost identical with a synthetic calcium silicophosphate of the approximate composition $8CaO, P_2O_5, 2.5SiO_2$ prepared by Trömel. H.E.S.

Calculation of heating time. J. D. KELLER. *Ind. Heating*, **6** [10] 904–16 (1939).—K. developed a graphical method for three-dimensional heat flow; it is applied especially to the heat flow in a sphere; a practical example is calculated. M.H.

Chemical analysis of clays. M. W. DE KEYSER AND M. E. PAHLAVOUNI. *Verre & Silicates Ind.*, **10** [24] 277–80; [25–27] 293–97 (1939).—A critical study was made of the method recommended by the A.S.T.M. for the analysis of clays. The changes which were adopted concerned the following points: (*a*) in fusing the specimen with caustic soda in a nickel crucible at about 450°, caustic soda which is as pure as possible should be used; (*b*) the nonvolatile residue after the attack of hydrofluoric acid on the silica must be combined with the filtrate of the silica before the precipitation of the R_2O_3 oxides; (*c*) not only the double precipitation by ammonia is recommended, but also the presence of a large excess of ammonium chloride (instead of 10 cc. of a 10% solution of NH_4Cl, 10 cc. of concentrated HCl are added before neutralization with ammonia, which amounts to about 6.3 g. NH_4Cl); elimination by nitric oxidation is also described; (*d*) the silica which might still be found in the calcined R_2O_3 oxides is disregarded, the loss being only a few hundredths of a per cent, and the gain in time is notable; (*e*) titanium is determined colorimetrically; (*f*) iron is determined by permanganic oxidation of iron reduced by nacent hydrogen. A résumé of the method of analysis as finally adopted is given: (*1*) *Sample:* grind about one-half liter and sift through a screen of 900 mesh per sq. cm. (*2*) *Humidity:* dry 5 g. substance in a tin layer (about 5 mm. thick) in a weighing bottle at 110° for 24 hr. (*3*) *Loss on firing:* heat 1 g. of dry substance in a silica glass crucible for $^1/_2$ hr. at 1000° in an electric furnace. (*4*) *Alkaline fusion:* weigh 1 g. of dry substance in a nickel crucible; add about 6 g. caustic soda for analysis and heat progressively to 450° in an electric furnace; retain at that temperature for $^1/_2$ hr. (*5*) *Silica:* dissolve the cooled mass in 100 to 150 cc. water and transfer to a porcelain dish containing 50 cc. of HCl (1:1); evaporate to dryness on a sand bath till the HCl vapors are eliminated; moisten the solid with 10 cc. concentrated HCl and, after 10 min., add 100 cc. water; heat, let digest 5 to 10 min., and filter in a rapid quantitative filter; wash with hot HCl (1:99) and then with hot water until the chlorine ion is eliminated; evaporate the filtrate to dryness again and repeat the operations as above but filter with a slow filter; calcine the silica in a platinum crucible with several drops of H_2SO_4 (1:4); heat 1 hr. at 1100°; weigh to constant weight in a large weighing bottle closed with a ground top and again add several drops of H_2SO_4 (1:4); eliminate the silica with hydrofluoric acid. The silica is given by the loss of weight. (*6*) R_2O_3: add pyrosulfate of potassium to the nonvolatile residue from the evaporation of the silica with hydrofluoric acid, dissolve with dilute H_2SO_4, and add to the silica filtrate. Reduce the solution obtained to 200 cc., oxidize with a little hydrogen peroxide at 3%, and add 10 cc. of concentrated HCl (this acid will form the necessary ammonium chloride); then carefully introduce, while boiling, dilute ammonia (1:1) slightly in excess; after filtration and quick washing with a hot dilute solution of ammonium nitrate (dilute 20 cc. of concentrated nitric acid, neutralize with the ammonia, and bring to 1 liter; reaction slightly alkaline), put the filter with the precipitate in the precipitating jar, redissolve the hydrates with dilute HCl (1:1), cut up the paper filter, and again precipitate with ammonia as above; after thorough washing with the hot dilute solution of ammonium nitrate (elimination of the chlorine ion), burn to ashes and calcine the precipitate in a porcelain or silica-glass crucible. Weigh the crucible with the calcined oxides in a large weighing jar. Combine the two ammoniacal filtrates and evaporate almost to dryness; eliminate the ammonium chloride, if necessary, by nitric oxidation and by addition of a little ammonia; determine if the precipitation of the hydrates has been complete. Save the filtrate for the determination of the alkaline earths. (*7*) *Titanium:* fuse the calcined oxides containing the iron and titanium with about 6 times their weight of potassium pyrosulfate; after cooling, dissolve the mass with dilute H_2SO_4 and bring to exactly 250 cc. Place 50 cc. in a 100 cc. balloon flask for the colorimetric determination of titanium; add 2.5 cc. of phosphoric acid (d = 1.7), 25.0 cc. H_2SO_4 (1:4), 2.5 cc. hydrogen peroxide of 3%, and water to bring the value to 100 cc. Compare the coloration obtained with a standard solution prepared in the same way and containing 0.0020 g. of TiO_2. The comparison is conveniently made in a Duboscq colorimeter: if h and h' are the heights of the liquids of the standard solution and the solution to determine the equality of tint, respectively, 0.0020 g. of TiO_2 in the 50 cc. of the initial solution corresponds to 1% in the total sample of 1 g., and $0.0020 \times 5 \times 100 = 1\%$ TiO_2, then $h/h' = \%$ TiO_2. The standard solution of titanium is obtained from the fluotitanate of potassium recrystallized and dried at 100°; prepare a solution containing about 0.001 g. of TiO_2 per cc.; verify the concentration by gravimetric analysis on 50-cc. samples; take a determined quantity, precipitate with ammonia, wash, and redissolve in H_2SO_4 at 5% in volume; 1 cc. of this solution must contain exactly 0.20 mg. of TiO_2. This solution (10 cc.) mixed with phosphoric acid, etc., and brought to 100 cc. as above, will give the comparison solution. (*8*) *Iron:* bring the remainder (200 cc.) of the sulfuric solution of the oxides of aluminum, iron, and titanium to 250 cc.; take 100 cc. twice in conical flasks of 250 cc.; add to each sample (each corresponding to $^4/_5 \times ^1/_5 = ^{32}/_{100}$ of the initial sample of 1 g.) 20 cc. of concentrated sulfuric acid after cooling, 2.5 cc. ammonia (1:1), 1 drop of a 10% solution of copper sulfate, 5 g. grated zinc, and 1 g. of powdered sodium bicarbonate and place the flasks immediately in communication with a saturated solution (7% of bicarbonate forming hydraulic "valve"). After complete reaction, verify the absence of ferric iron with filter paper soaked in potassium sulfocyanate, leave in air, and wait till the beginning of the oxidation of iron; then add a pinch of powdered bicarbonate, heat to 70°, and titrate with a 0.02 *N* solution of potassium permanganate. Take from the volume of permanganate that used by the same quantity of zinc and which has been determined by a blank test. (*9*) *Calculation:* 1 cc. of 0.02 *N* permanganate corresponds to 0.0016 g. Fe_2O_3; $\% Fe_2O_3 = 100 \times 100/32 \times n \times 0.0016 = n/2$ (n cc. = corrected volume of permanganate). (*10*) *Lime:* in the ammonia filtrate of the R_2O_3 hydrates treated as is indicated above, a double precipitation is made of the lime in the usual way, by the oxalate of ammonium in the state of calcium oxalate; after filtration and washing, the precipitate is redissolved by dilute sulfuric acid and the oxalic acid liberated is titrated by potassium permanganate. (*11*) *Magnesia:* in the lime

filtrate the magnesia is precipitated twice by diammoniac phosphate and it is weighed in the pyrophosphate state. M.V.C.

Comparison of dry combustion and rapid dichromate titration methods for organic matter determinations. G. M. BROWNING. *Soil Sci. Soc. Amer., Proc.*, **3**, 158 (1938).—The dry combustion method was the more accurate method, but the titration method gave valuable approximate results. R.K.

Formation of magnesium titanates from oxides in the solid state. W. JANDER AND K. BUNDE. *Z. Anorg. & Allgem. Chem.*, **239** [4] 418–26 (1938).—$MgO{\cdot}TiO_2$ is the primary product and is formed at 850° to 1090°C when MgO and TiO_2 are heated together. With an excess of TiO_2, $MgO{\cdot}2TiO_2$ results without difficulty, while $2MgO{\cdot}TiO_2$ forms much slower when MgO is in excess. W.K.

Microgravimetric separation of zinc and uranium. EDITH KROUPA. *Mikrochemie*, **27**, 1–7 (1939).—Separation of zinc from uranium is carried out by precipitating the zinc, according to C. Mayr's macro procedure, as zinc sulfide in a solution buffered with monochloracetic acid and sodium acetate; the precipitate is redissolved in HCl and the zinc is determined as zinc ammonium phosphate. The filtrate containing the uranium is evaporated and treated with hydrochloric acid and bromine water. The uranium is then determined by precipitation in the usual way with 8-hydroxyquinoline in acetic acid solution containing some ammonium acetate. L.E.T.

Microtitration method for determining the readily soluble boron. R. L. COOK AND C. E. MILLER. *Soil Sci. Soc. Amer., Proc.*, **3**, 146 (1938).—A modification of the distillation method for determining boron is given. *N*/50 H_2SO_4 is used to extract the boron. R.K.

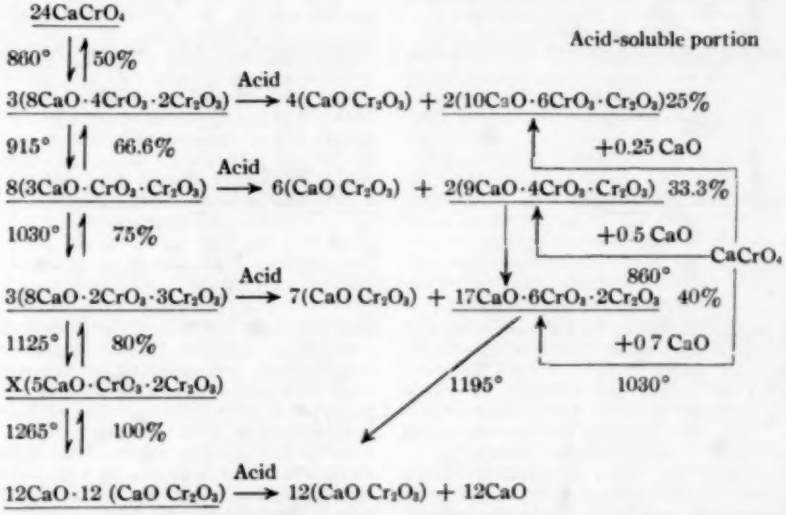
Mixed crystals of cryolite with alumina. E. ZINTL AND W. MORAWIETZ. *Z. Anorg. & Allgem. Chem.*, **240** [2] 145–49 (1938).—According to previous publications, the solubility of alumina in cryolite is about 11%. X-ray pictures of fusions with 5, 10, and 15% show that the solubility lies between 10 and 15%. The alumina substitutes for part of the cryolite according to the following scheme. $Na_3\,Al\,F_6$. This is proved also by density measurements. $Al_3\,Al\,O_6$. W.K.

Plastic flow of dispersions and new approach to study of plasticity. PAUL S. ROLLER. *Jour. Phys. Chem.*, **43**, 457 (1939).—Dispersions such as grease, clay paste, lime putty, and cement mortars, although seemingly liquid, possess rigidity due to the structure of the disperse phase. The sum of the plastic resistance and the viscous resistance gives the total resistance opposing change of form. A law of plastic flow is given in which two constants are identified, coefficient of renitence and yield value. Workability depends on both these constants. The theoretical treatment assumes that the rigidity of a dispersion is due to the sum total force of attraction between the particles of the disperse phase. Factors that determine this force have been tested, and good agreement between the theoretically expected and experimental results for plasticity and cohesion have been obtained. Measurements were made of the continuous deformation of a cylinder of the specimen compressed between two thin plates when a uniformly increasing load was applied. The various types of deformation curves thus obtained are discussed. See *Ceram. Abs.*, **18** [5] 139 (1939). R.A.G.

Quantitative determination of magnesium. O. ALEXANDER AND H. J. HARPER. *Soil Sci. Soc. Amer., Proc.*, **3**, 153 (1938).—The gravimetric, colorimetric, and volumetric methods of determining exchangeable magnesium by the 8-hydroxyquinoline method are compared. R.K.

Reactions of chromates at high temperatures: III, Decomposition of calcium chromate. V. T. ATHAVALE AND S. K. K. JATKAR. *Jour. Indian Inst. Sci.*, **20A** [8] 55–66 (1937).—One of the paradoxes of the reactions in the chromate furnace is the fact that under the conditions recommended for obtaining a good yield of chromate the chromate itself is not stable. The method consists of roasting, in an oxidizing flame, the powdered mineral mixed with lime in the ratio 1:1.6 to 1.9 for chromium to calcium; a higher ratio is used if the furnace is to be operated above 1100°C. Calcium chromate actually decomposes under these conditions. Nayer, Watson, and Sudborough (Part I, *Ceram. Abs.*, **4** [8] 228 (1925)) found that calcium chromate decomposed more readily on addition of lime, a 33% decomposition being observed at 800°C. A systematic work on the decomposition of calcium chromate alone and in admixture with lime was carried out by Nargund and Watson (Part II, *ibid*., **6** [10] 475 (1927)) who pointed out the complex nature of the system $CaO–Cr_2O_3–O_2$ and tentatively suggested the existence of a large number of compounds of calcium oxide, chromic oxide, and chromium trioxide in various proportions: (*1*) $CrO_3{\cdot}CaO$: dissociation pressure 15 mm. at 950°C, 44 mm. at 1000°C; decomposes to *6*. (*2*) $CrO_3{\cdot}{}^3/_2CaO$: quantity of CaO somewhat uncertain; dissociation pressure 188 mm. at 835°C, 358 mm. at 855°C; decomposes to *3*. (*3*) ${}^1/_4Cr_2O_3{\cdot}CrO_3{\cdot}2CaO$: formed by heating *2*; dissociation pressure about 270 mm. at 910°C; below this it decomposes to *4*. (*4*) ${}^1/_4Cr_2O_3{\cdot}CrO_3{\cdot}{}^9/_4CaO$: or possibly 2CaO formed from *3* or by heating CaO and $CaCrO_4$ in air; black substance soluble in dilute acids; dissociation pressure 22 mm. at 920° and 45 mm. at 1000°C, the compound *5* being formed. (*5*) ${}^1/_3Cr_2O_3{\cdot}CrO_3{\cdot}2CaO$: formed from *4* or by supplying oxygen at a pressure less than 20 mm. to a mixture of Cr_2O_3 with more than 1 mol. of CaO; soluble in acid; dissociation pressure not measurable at 1030°C. (*6*) $Cr_2O_3{\cdot}CrO_3{\cdot}3CaO$ (formula somewhat doubtful): the first decomposition product of pure calcium chromate; also formed on supplying oxygen under pressure less than 20 mm. to a mixture of Cr_2O_3 with 2 mol. of CaO at 1030°C. (*7*) ${}^3/_2Cr_2O_3{\cdot}CrO_3{\cdot}4CaO$: decomposes at about 2 mm. at 1030° to give *8*. (*8*) $2Cr_2O_3{\cdot}CrO_3{\cdot}5CaO$: the final decomposition product of calcium chromate with no appreciable dissociation pressure at 1030°C. (*9*) ${}^1/_2Cr_2O_3{\cdot}CrO_3{\cdot}CaO$ (quantity of Cr_2O_3 uncertain): formed by heating calcium chromate with Cr_2O_3; dissociation pressure 22 mm. at 930°C, 90 mm. at 990°C, and 150 mm. at 1030°C, yielding compound *9*. (*10*) $Cr_2O_3{\cdot}2CaO$: the simplest chromite obtained by heating compound *9 in vacuo*. (*11*) $2Cr_2O_3{\cdot}2CaO$: obtained when mixtures of CaO and Cr_2O_3 are heated *in vacuo;* 1 mol. of CaO is soluble in acid yielding compound *12;* the quantity of CaO is not quite definite. (*12*) $2Cr_2O_3{\cdot}CaO$: obtained from *11* on treatment with acid. Although the experiments described by Nargund and Watson were tentative, their results appear plausible on the basis of the existence of a number of intermediate chromium oxides which may be regarded as chromium chromates. Thus chromium trioxide, when heated, passes through a number of intermediate stages before decomposing to chromium sesquioxide. Mellor has given the nomenclature for the intermediate chromic oxides reported by different authors and for the various calcium compounds reported by Nargund and Watson, which has been adopted in this paper. As the existing data on the subject of decomposition of calcium chromate are not satisfactory, the authors have undertaken the systematic study of the thermal decompositions of this substance and extended the research to the decomposition of strontium and barium chromates for which no data are available. The results obtained with pure calcium chromate, which was only partially studied by Nargund and Watson, are described. Calcium chromate passes through four stages corresponding to 50, 66.6, 75, and 80% of the complete decomposition, the range of temperatures over which these are stable being 800° to 850°C, 850° to 920°C, 920° to 1080°C, and 1080° to 1125°C, respectively. Calcium chromate decomposes completely above this temperature at low pressures. The vapor pressures of these intermediate stages were measured and the heats of decomposition were calculated. The products corresponding to these stages which resisted further decomposition *in vacuo* partly dissolved in acids, leaving an insoluble residue which was identified as calcium chromite. Considerations based upon the acid-soluble chromium trioxide and sesquioxide in the product, taken along with the formula of the corresponding chromium chromates, show that the steps observed during the decomposition of the calcium chromate are due to the formation of the following compounds: (1)

$8CaO \cdot 4CrO_3 \cdot 2Cr_2O_3$, (2) $9CaO \cdot 4CrO_3 \cdot Cr_2O_3$, (3) $17CaO \cdot 6CrO_3 \cdot 2Cr_2O_3$, (4) $3CaO \cdot CrO_3 \cdot Cr_2O_3$, (5) $3CaO \cdot CrO_3 \cdot 2Cr_2O_3$, (6) $8CaO \cdot 2CrO_3 \cdot 3Cr_2O_3$, and (7) $10CaO \cdot 6CrO_3 \cdot Cr_2O_3$. The stability of chromates in the chromate furnace is due to the formation, during the reaction, of these intermediate compounds which are far more stable than pure chromate itself. **IV, Decomposition of mixtures of calcium chromate with calcium carbonate.** *Ibid.*, **21A** [11] 119–29 (1938).—The decomposition of mixtures of calcium chromate and lime *in vacuo* indicates two additional stages corresponding to 33.3 and 40% decomposition. The formulas of the two compounds formed are $9CaO \cdot 4CrO_3 \cdot Cr_2O_3$ and $17CaO \cdot 6CrO_3 \cdot 2Cr_2O_3$, respectively; they agree with the composition of the acid-soluble portions from the 66.6 and 75% stages for the decomposition of pure calcium chromate. The vapor pressures of these compounds were measured and the heats of decomposition were calculated. The intermediate stages formed in the decomposition of pure calcium chromates may not all be mixtures of the above compounds with calcium chromite, as they are characterized by definite vapor pressure and heats of decomposition, the values of which are quite distinctly different; the dissociation pressures of the 75% stage for pure chromate and of the 40% stage for mixtures are very low and nearly identical, however, and may indicate that the compounds formed in both the cases are the same. The results of the decomposition of calcium chromate and of its mixtures with lime at low pressures (< 0.2 mm.) may be summarized as follows:



Acid-soluble portion

In the chromate furnace, the oxidation of chromite necessarily occurs through the formation of the intermediate stages. The addition of lime in the ratio of 1:1.6 to 1.9 for the ratio of Cr:Ca is recommended when the furnace is to be operated above 1100°C, because the compound $17CaO \cdot 6CrO_3 \cdot 2Cr_2O_3$ has comparatively low decomposition pressure. The maximum conversion of the chromite under these conditions is 60%. **V, Decomposition of strontium chromate.** *Ibid.*, [15] 159–67.—The experiments on the decomposition of strontium chromate confirm the results obtained in the decomposition of calcium chromate and indicate stages in the decomposition corresponding to 50, 66.6, and 75% decomposition, the range of temperatures over which these are stable being 930° to 1200°C, 1225° to 1300°C, and 1325° to 1450°C, respectively, at 0.2 mm. pressure. The stages in the decomposition corresponding to 80% and complete decomposition could not be obtained for want of suitable materials to carry out experiments in vacuum above 1450°C. The vapor pressures of the intermediate stages were measured and the heats of dissociation were calculated from them. The products corresponding to 50 and 66.6% stages, which resisted further decomposition in vacuum, partly dissolved in warm acetic acid leaving an insoluble residue which was identified as chromic oxide in the former case and strontium chromite in the latter. The steps observed in the decomposition of strontium chromate are due to the formation of the following compounds: (1) $8SrO \cdot 4CrO_3 \cdot 2Cr_2O_3$, (2) $8SrO \cdot 4CrO_3 \cdot Cr_2O_3$, (3) $9SrO \cdot 4CrO_3 \cdot Cr_2O_3$, (4) $3SrO \cdot CrO_3 \cdot Cr_2O_3$, and (5) $8SrO \cdot 2CrO_3 \cdot 3Cr_2O_3$. Compounds 2 and 3 are the strontium salts of the same chromium chromate, $4CrO_3 \cdot Cr_2O_3$, but differ in the amounts of strontium oxide required for the formation of the compounds. Compound 2 was not obtained in the study of the decomposition of calcium chromate. Strontium chromate melts at 1200° and decomposes completely above this temperature. **VI, Decomposition of mixtures of strontium chromate and strontium carbonate.** *Ibid.*, [17] 179–88.—The decomposition of mixtures of strontium carbonate and strontium chromate confirms the results obtained with mixtures of calcium carbonate and lime and indicates additional stages in the decomposition at 33.3 and 40% which were not obtained in the decomposition of pure strontium chromate. A stage in the decomposition at 25% is also indicated. Attempts are being made to isolate this stage and to study its decomposition pressure. The dissociation of the mixtures of strontium carbonate and strontium chromate starts with the evolution of carbon dioxide and oxygen simultaneously and at a much lower temperature than that required for the dissociation of either of the components independently, the ratio of CO_2/O_2 in the gas phase being 2:1. The formulas of the compounds corresponding to 33.3 and 40% decomposition are 8SrO(and 9SrO)$\cdot 4CrO_3 \cdot Cr_2O_3$ and $17SrO \cdot 6CrO_3 \cdot 2Cr_2O_3$, respectively. The former was also represented by the acid-soluble portion of the 50 and 66.6% stages observed in the decomposition of strontium chromate and showed remarkably increased stability in combination with the extra base. The results of the decomposition of strontium chromate and of the mixtures of strontium chromate with strontium oxide may be summarized as shown in the diagram on the following page.

The decomposition pressures of the various stage sindicate that the products formed at 50 and 66.6% and at 75% decomposition of pure strontium chromate are probably mixtures of the compounds formed at 33.3 and 40% stages, respectively, which were observed in the case of decomposition of mixtures of strontium chromate with strontium oxide and with chromium oxide or chromite. While pure strontium chromate begins to dissociate at 925°C and pure strontium carbonate begins to dissociate at 775°C, a mixture of the two begins to dissociate at only 600°C. The reaction between the strontium chromate and strontium carbonate was found to be more intense than that between calcium carbonate and calcium chromate, and this explains why strontium carbonate is preferred to calcium car-

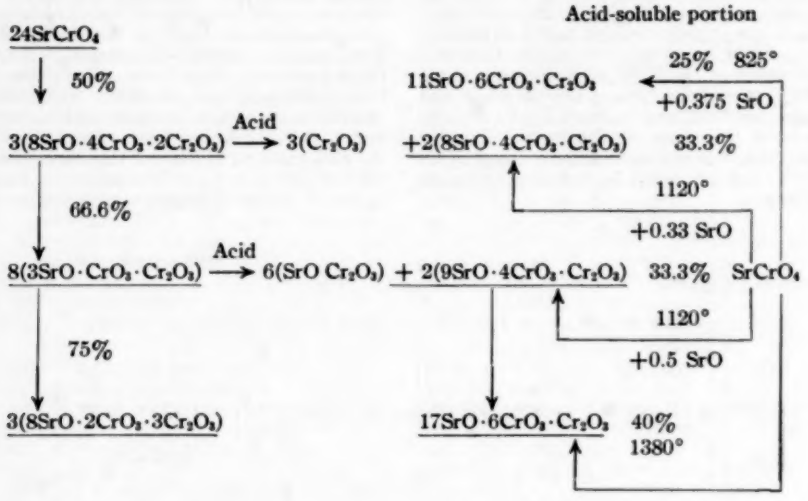
bonate in the manufacture of chromates. **VII, Decomposition of barium chromate and of mixtures of barium chromate with barium carbonate.** *Ibid.*, [23] 273–83.—The dissociation pressure of pure barium chromate was measured up to 1400°C and the heat of decomposition was calculated. A stage at 50% decomposition was observed as in the case of calcium and strontium chromates. The compound formed at this stage is $8BaO \cdot 4CrO_3 \cdot 2Cr_2O_3$, which has practically no dissociation pressure at 1420°C and which yields an acid-soluble product of the composition $8BaO \cdot 4CrO_3 \cdot Cr_2O_3$. The decomposition of mixtures of barium chromate and barium carbonate was more energetic than that observed in the corresponding experiments with calcium and strontium compounds. The mixtures begin to dissociate at 740°, while the dissociation temperatures for pure chromate and carbonate are 1200° and 1000°, respectively. Stages at 25, 33.3, and 40% were found in the decomposition of the chromate in the mixtures, due to the formation of the compounds $12BaO \cdot 6CrO_3 \cdot Cr_2O_3$, $9BaO \cdot 4CrO_3 \cdot Cr_2O_3$, and $17BaO \cdot 6CrO_3 \cdot 2Cr_2O_3$, respectively. The intensity of the reaction between the chromate and carbonate increases in the order calcium, strontium, and barium. **VIII, 25% stage in the decomposition of the chromates of calcium, strontium, and barium.** D. S. Datar, V. T. Athavale, and S. K. K. Jatkar. *Ibid.*, **22A** [7] 111–18 (1939).—The decomposition of the mixtures of calcium, strontium, and barium chromates with the corresponding carbonates in different proportions has been studied at comparatively lower temperatures, special care being taken to allow the reactions between the solids to reach equilibrium. The results show a 25% decomposition of the chromate due to the formation of the compound $12RO \cdot 6CrO_3 \cdot Cr_2O_3$ which is preceded by the formation of the basic chromate $3RO \cdot 2CrO_3$. The decomposition pressures of the above compounds have been measured, and the calculated heats of decomposition of the compounds of calcium, strontium, and barium are 26.9, 38.4, and 62.3 cal., respectively. **IX, Thermal decomposition of chromium trioxide.** D. S. Datar and S. K. K. Jatkar. *Ibid.*, [8] 119–26.—The thermal decomposition of chromium trioxide has been studied in a closed system maintained at constant temperature by following the rate of decomposition at various stages. The results indicated the formation of intermediate compounds at 25, 33.3, 40, and 50% of the complete decomposition which were characterized by distinctive rates of decomposition and heats of activation. The existence of the above stages in the decomposition of the chromium trioxide is in agreement with the results obtained in the decompositions of the mixtures of chromates of the alkaline earths with the corresponding oxides. There was apparently no stage at 26.86%, which was obtained by previous workers. The higher stages at 66, 75, and 80%, obtained in the decomposition of the pure chromates, if they exist, are not characterized by appreciably different rates of decomposition. A.P.S.

Reactions in the solid state with mixtures of active Fe_2O_3 and CaO. J. A. Hedvall and S. O. Sandberg. *Z. Anorg. & Allgem. Chem.*, **240** [1] 15–20 (1938).—The speed of reaction of various forms of Fe_2O_3 with CaO was investigated. The active sulfate oxide shows a higher reactivity in spite of a larger grain size than the oxalate oxide, especially at 700° to 800°C; γ $Fe_2O_3 \cdot H_2O$ oxides have a high reactivity below 500°C. This is due mainly to the labile structure of the forming γ Fe_2O_3. W.K.

Relation between viscosity and elastic properties of amorphous substances. W. Kuhn. *Z. Physik. Chem.* **B42** [1] 1–38 (1939).—K. discusses the relation between the torsion modulus, relaxation time, and the viscosity of a substance, first reported by Maxwell. It is considered that in a given substance several cohesion mechanisms, possessing different relaxation times, are present. The total viscosity of a substance, therefore, is equal to the sum of partial viscosities. The following chapters are discussed: (*a*) the appearance of elastic tension in a flowing substance (close relation exists in glass between the elastic tension and viscosity); (*b*) the elastic tension with sudden (jerky) deformation followed by decrease in tension; (*c*) repeated production of tension and release synonymous with irregular flow; (*d*) elastic tension, relaxation, energy expenditure, and viscosity at continuous flow; and (*e*) the question regarding the validity of the relaxation theory of the viscosity of easily flowing substances. Another chapter deals with the relaxation time and the viscosity of highly viscous materials at and above the transformation point of glasses. The viscosity and elasticity of rubber and highly polymerized compounds are also discussed. L.E.T.

Research on reactions between solid phases. Wilhelm Jander. *Österr. Chem.-Ztg.*, **42** [7] 145–51 (1939).—J. gives a theoretical report on new research, together with a bibliography. Examples include $MgO + TiO_2$ and several silicates. J.M.N.

Silicate–water systems. Phase equilibria in the $NaAlSi_3O_8$–H_2O and $KAlSi_3O_8$–H_2O systems at high temperatures and pressures. Roy W. Goranson. *Amer. Jour. Sci.*, **35A**, 71–91 (1938).—Phase relations in the albite–water and orthoclase–water systems are determined between 800° and 1200°C at pressures up to 4000 bars. The freezing-point curves of these systems which extend



out into three-dimensional temperature-pressure-concentration space have been completed for the albite-water system. The orthoclase–water system is more complex in that, at pressures less than about 2600 bars, orthoclase melts incongruently to leucite and liquid. The solubility of water in this liquid has not yet been completely determined as a function of temperature and pressure, and only the projection of the freezing-point curve on the temperature-pressure plane is given. Pressure-volume-temperature relations for water are derived, chiefly by extrapolation, and are used to calculate apparent volumes and heats of evaporation. The pressures developed on crystallization may exceed those necessary to explain certain volcanic phenomena. See *Ceram. Abs.*, **17** [1] 44 (1938). J.B.A.

Solution of solid water glass in water. W. J. MÜLLER, W. MACHU, AND W. STIDL. *Z. Anorg. & Allgem. Chem.*, **236** [1–4] 232–42 (1938).—The influence of the proportion of water and the temperature upon the solubility of solid water glass was investigated, especially the influence upon the decomposition of the water glass and the distribution of the alkali between the solution and the undissolved part. If the water glass is in excess, it dissolves without difficulty in water at 100°C. A 35% solution still has a high dissolving power and the composition does not change during solution. A continuous process of solution at 100°C is therefore possible on a large scale. Solutions effected at 100°C are less viscous than those made at 150° to 170°C. W.K.

System leucite–diopside–silica. J. F. SCHAIRER AND N. L. BOWEN. *Amer. Jour. Sci.*, **35A**, 289–309 (1938).—A preliminary melting diagram is given for the system leucite ($KAlSi_2O_6$)–silica. In the ternary system leucite–diopside($CaMgSi_2O_6$)–silica there are no ternary compounds. A noteworthy feature is the extension of the field of diopside from the pure compound nearly to the binary boundary leucite–silica. Diopside is the first crystalline phase to appear on cooling, even when less than 2% diopside is present. For mixtures in this system, diopside is removed almost quantitatively on cooling, leaving a residual liquid which is almost pure potash feldspar and silica. The binary invariant point between potash feldspar, tridymite, and liquid is at 990 ± 20°C; that between leucite, potash feldspar, and liquid is at 1100 ± 20°. The invariant point between tridymite, cristobalite, and liquid (80% SiO_2, 20% leucite) is at 1470 ± 10°. There are two ternary invariant points, one, a ternary reaction point between leucite, potash feldspar, diopside, and liquid, which is below 1100°C, and the other, a ternary eutectic between potash feldspar, diopside, tridymite, and liquid, which is below 990°C. The refractive index at 25°C is given for the glasses in the system. J.B.A.

System $Na_2O \cdot Al_2O_3 \cdot 2SiO_2$ (nephelite-carnegieite)–$Na_2O \cdot Al_2O_3 \cdot 6SiO_2$ (albite). J. W. GRIEG AND TOM F. W. BARTH. *Amer. Jour. Sci.*, **35A**, 93–112 (1938).—All temperatures are on the Day and Sosman scale. The equilibrium diagram of this system is very similar to that for the corresponding system nephelite, carnegieite–anorthite. The melting point of albite lies between 1115° and 1120°C, probably at 1118°C. This was determined by finding a temperature at which crystals of albite melt and a second temperature at which they grow in albite liquid. Small crystals of albite are grown in a homogeneous glass of albite composition and the material so prepared is held at constant temperature and then compared under the microscope with the original material. The melting point of carnegieite lies between 1524° and 1527°C, probably at 1526°C. The nephelite-carnegieite inversion is at 1254 ± 5°C. It is raised by the presence of albite and takes place over a range of temperature. The eutectic between nephelite and albite is at 76% albite and 1068 ± 5°C. There is some indication that albite can, at 1075°C, dissolve about 4% nephelite in solid solution. Apparently jadeite ($Na_2O \cdot Al_2O_3 \cdot 4SiO_2$) is not a stable phase. A schematic diagram is given for the system nephelite, carnegieite–anorthite–albite. J.B.A.

Systems zinc oxide–iron oxide and beryllium oxide–iron oxide. G. F. HÜTTIG. *Z. Anorg. & Allgem. Chem.*, **237** [3–4] 209–325 (1938).—The oxides of zinc and iron, dead-burned and finely pulverized, were intimately mixed and kept at definite elevated temperatures for definite periods of time. The reaction products were tested by the following methods and for the following properties: X-ray spectrometry, magnetic susceptibility, weight by volume, color, absorption of vapors of methanol at constant temperature and varying pressure, absorption of dyes in solution, catalytic activity toward the decomposition of oxides of nitrogen, and the ketonizing of alcohols. The usual mixture was the stoichiometric one of ZnO Fe_2O_3; other proportions were also investigated as well as the oxides alone. The series BeO–Fe_2O_3 was run because this pair does not form a compound or a solid solution. W.K.

X-ray studies of compounds in the system PbO–SiO_2. HOWARD F. MCMURDIE AND ELMER N. BUNTING. *Jour. Research Nat. Bur. Standards*, **23** [4] 543–47 (1939).—X-ray diffraction powder patterns were made on various compositions in the system PbO–SiO_2 in order to check the presence of certain reported compounds. It was found that 3 binary compounds exist: $PbO \cdot SiO_2$ (same as the mineral alamosite), $2PbO \cdot SiO_2$, and $4PbO \cdot SiO_2$. The latter occurs in at least two polymorphic forms. The powder patterns of the alpha and beta forms of PbO are also given. R.A.H.

PATENTS

Coherent zirconium silicates. C. J. KINZIE (Titanium Alloy Mfg. Co.). U. S. 21,224, Oct. 3, 1939 (June 2, 1939; reissue of 2,101,947 (*Ceram. Abs.*, **17** [2] 87 (1938)).—A coherent fired zirconium silicate comprises zirconium silicate interstitially bonded with a minor quantity of a double silicate of zirconium and a metal taken from the group consisting of alkali metals, alkaline-earth metals, and magnesium, together with the reaction product of an acid chosen from the group H_3PO_4, HCl, H_2SO_4, and HNO_3 therewith.

Decolorizing titanium tetrachloride. FREDERICK GAGE (Pittsburgh Plate Glass Co.). U. S. 2,178,685, Nov. 7, 1939 (Feb. 3, 1938).—A method of decolorizing colored titanium tetrachloride comprises contacting it with a lower valent titanium compound in an amount sufficient and for the time required to remove at least a substantial portion of the color from the tetrachloride.

Making sodium chromates. M. J. UDY. U. S. 2,176,685, Oct. 17, 1939 (Nov. 30, 1937).—In the production of chromate compounds involving oxidation of ferrochromium in finely divided form at an elevated temperature below the fusing temperature of the ferrochromium and in the presence of calcium oxide and sodium carbonate, the improvement comprises employing sodium carbonate in the amount required to form sodium chromate with about half the chromium of the ferrochromium and employing calcium oxide in an amount in excess of that required to form calcium chromate with the remainder of the chromium of the ferrochromium, thereby to form an oxidized product containing sodium chromate and calcium chromate in about equimolecular proportions.

Manufacture of aluminum fluoride from noncalcined Al_2O_3 or $Al(OH)_3$. O. ORLANDI. Fr. 848,982, July 22, 1938. D.A.B.

Manufacture of chromates. M. J. UDY. Brit. 513,152, Oct. 18, 1939 (Nov. 30, 1937).

Manufacture of hydrated sodium tetrasilicate. W. F. WEGST AND J. H. WILLS (Philadelphia Quartz Co.). U. S. 2,179,806, Nov. 14, 1939 (Nov. 18, 1936).—(3) In the process of manufacturing crystalline silicates, a step comprises seeding a sodium silicate solution containing more SiO_2 than is represented by the molecular ratio of $1Na_2O$ to $2SiO_2$ and containing not substantially more than about 75% of water with crystals having a molecular ratio of Na_2O to SiO_2 of 1 to 4 and containing approximately 7 mols. of water. (8) The process comprises heating a sodium silicate solution containing SiO_2 in amount greater than that represented by the molecular ratio of $1Na_2O$ to $2SiO_2$ to temperatures ranging from about 60° to 90°C under conditions of agitation for a time sufficient to grow crystals having a molecular ratio of Na_2O to SiO_2 of 1 to 4 and containing about 7 mols. of water.

Manufacturing green ceramic colors. GUSTAV JAEGER AND HEINRICH DIEHL (Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler). U. S. 2,180,056, Nov. 14, 1939 (Feb. 1, 1937).—A green ceramic color of superior heat resistance consists of the product obtained by heating together, to a temperature within the range of about 1100° to about 1500°C, a beryllium compound selected from the group which consists of beryllium oxide and compounds of beryllium yielding beryllium oxide under the conditions of heating and a chromium compound selected from the group which consists of chromium oxide and chromium compounds yielding chromium oxide under the conditions of heating.

Producing alkali subsilicates. PENNSYLVANIA SALT MFG. CO. Fr. 825,893, Aug. 25, 1937. D.A.B.

Producing cadmium selenide. N. E. GORDON AND E. C. PITZER (Chemical Foundation, Inc.). U. S. 2,176,495, Oct. 17, 1939 (May 20, 1937).—A method of producing substantially pure cadmium selenide comprises reacting cadmium sulfate in aqueous medium with a substantial excess of alkali selenosulfate, hydrolyzing the formed cadmium selenosulfate to cadmium selenide in the presence of the selenosulfate at a temperature of between 60° and 100°C, filtering the precipitate, and reëmploying the filtrate with additional amounts of cadmium sulfate to produce an additional quantity of the cadmium selenide.

Producing polyphosphates and polyphosphate mixtures. FERDINAND BORNEMANN AND HANS HUBER. U. S. 2,174,614, Oct. 3, 1939 (Dec. 28, 1936).—A process for the preparation of sodium tripolyphosphate corresponding to the formula $Na_5P_3O_{10}$ from a sodium phosphate melt having a stoichiometric $Na_2O:P_2O_5$ ratio of 1.667 comprises cooling the melt to bring it to the solidification point and then further cooling it at an extremely slow rate below the softening temperature but above 300°C until substantially complete conversion to tripolyphosphate form is achieved.

Production of alkaline-earth metals. F. R. KEMMER. U. S. 2,179,823, Nov. 14, 1939 (Dec. 30, 1938).—A process of producing an alkaline-earth metal comprises forming a mixture of aluminum and a finely divided material bearing an oxide of the alkaline-earth metal, heating the mixture to a temperature above the melting point of the aluminum and below the boiling point of the alkaline-earth metal, evacuating the heated mixture, admitting an inert gas to the evacuated mixture so as to force molten aluminum into intimate association with the material, then heating the mixture to the temperature of volatilization of the alkaline-earth metal, and distilling the metal.

Production of ferric oxide. U. E. BOWES. U. S. 2,176,242, Oct. 17, 1939 (June 26, 1934; renewed April 20, 1938).

Removing water from silicic acid. I. G. FARBENIND. A.-G. Fr. 848,885, Jan. 14, 1939. D.A.B

General

Administration of laws on occupational diseases. THEODORE C. WATERS. *Amer. Jour. Pub. Health*, **29** [7] 728–38 (1939).—Several cases are cited to illustrate the judicial interpretation of the term "occupational disease." Provisions are discussed for the creation and functioning of a medical board to act in an advisory capacity to an administrative agency of the compensation boards. B.C.R.

Center of ceramic population. RAYMOND E. BIRCH. *Bull. Amer. Ceram. Soc.*, **18** [10] 409 (1939).

Ceramic materials for special duty. E. RYSCHKEWITSCH. *Schweiz. Arch. Angew. Wiss. Tech.*, **5** [7] 203–208 (1939).—R. describes new ceramic materials formed by sintering homogeneous oxides and compares them with the usual ceramic materials made from heterogeneous mixtures. They are thoria, spinel, beryllia, zirconia, magnesia, alumina, and ceria. They are not plastic except in a colloidal state which cannot be achieved by economical technical means. Bonds which later transform into the same materials (zirconium oxychloride for zirconia, aluminum hydroxide for alumina, etc.) or organic bonds which volatilize during firing are therefore used. The now plastic materials can be shaped as usual. The temperatures for firing exceed those required for hard porcelain and go up to 2000°C. A kiln which is used for sintering is described. The properties are given. The materials can be used in high vacuum and are more corrosion resistant and have higher electric and mechanical properties than regular ceramics. R. gives details on the application of these materials. Illustrated. J.M.N.

Certain dusts produced by mining processes. H. S. PATTERSON. *Bull. Inst. Mining & Met.*, No. 417, pp. 1–14 (1939).—Silicosis found in the manufacture of silicon alloys is considered to be due to the silica smoke produced from the arc chamber. The average particle size of this fine smoke is of the order of 0.1 micron. The harder the solid to be mined, the finer will be the dust produced. Thus, with a hard rock such as quartzite, 70 to 80% of the dust particles are about $^1/_4$ of a micron or smaller in size, while over 90% are under 1 micron. The most important conclusion is that wet drilling releases more fine dust than dry drilling, due to the electrification of the dust produced in dry drilling. In the presence of water no marked electrification of the particles takes place, so that the fine dust is not removed in this way. Wet drilling, therefore, cannot be regarded as a preventive against silicosis. 11 figures. R.H.

Industrial housekeeping with dust collectors. C. A. SNYDER. *Ceram. Ind.*, **29** [4] 271 (1937).—The problem of dust suppression in the ceramic industry, while complex in type (involving the collection of fine and heavy dust, hot dust and fumes from furnaces, sharp dust from enameling and fritting operations, and silica dusts), is easily remedied by the proper application of modern dust-suppression equipment. For industrial dust control it is necessary to (1) select the best method of suppression, which usually means the adoption of one of the several types of cloth screen, tube, or bag type dust collectors; (2) determine the placement, size, and type of hoods and nozzles required for ventilating and cleaning up dusty rooms and buildings; and (3) select the proper size unit and the logical location for the dust-arrester installation. Types of dust suppressors are discussed. The importance of determinations of severity of dust exposure is stressed. E.J.V.

Mechanism of applied scientific researches and the possibilities of collective research on the professional plan: I–II. A. BERTIN. *Chaleur & Ind.*, **20** [229] 347–55; [231] 446–55 (1939).—From a detailed consideration of various types of research problems, B. concludes that rarely is the isolated investigator capable of solving them effectively. To avoid fruitless efforts and duplication, he suggests the establishment of a central government research organization to direct efforts to useful problems, to encourage coöperation between workers, to link the research laboratory with industrial practice, and to document research records effectively. V.D.F.

Prevention of silicosis by metallic aluminum: II. J. J. DENNY, W. D. ROBSON, AND D. A. IRWIN. *Bull. Inst. Mining & Met.*, No. 415, pp. 5–20 (1939); see *Ceram. Abs.*, **18** [9] 260 (1939). R.H.

Sampling of mine dusts with thermal precipitator. H. S. PATTERSON. *Bull. Inst. Mining & Met.*, No. 417, pp. 1–7 (1939).—The apparatus described by H. L. Green and H. H. Watson (*Ceram. Abs.*, **15** [6] 195 (1936)) was used. Certain modifications of the methods of sampling and the subsequent examination of the dust records were introduced, details of which are given. Illustrated. R.H.

Silicosis and lead poisoning among pottery workers. R. H. FLINN, J. J. BLOOMFIELD, R. R. SAYERS, ET AL. *U. S. Pub. Health Bull.*, No. 244, 178 pp.; abstracted in *U. S. Pub. Health Rept.*, **54** [15] 613–16 (1939).—Nine West Virginia factories (employing 1627 men and 889 women) engaged in the manufacture of tableware, sanitary

ware, electrical porcelain, and wall and floor tile are involved in this comprehensive engineering and medical research study. The inquiry arose when the Commissioner of Health in West Virginia in 1936 asked the U. S. Public Health Service to make a survey of the prevalence of silicosis among pottery workers in the state which would enable the State Compensation Commissioner to set rates for plants desiring coverage by the Workmen's Compensation Silicosis Fund. The survey recently published includes descriptions of the manufacturing processes obtaining in the pottery industries; it is supplied with a glossary of trade names and operations and has 23 medical case histories, each one accompanied by a chest radiograph. Medical findings and statistics are given for the employees who are in the first three stages of silicosis. Approximately three fourths of the workers employed in the clay shop for more than 30 years and half of the slip house and kiln workers employed for the same length of time had silicosis. No cases were found in the decorating departments or the mold shops. It is believed that if dust concentrations in potteries can be kept below 14 million particles per cu. ft., no new cases of silicosis will develop. When workers had been subjected to dust concentrations exceeding 16 million particles per cu. ft. for 30 years, 9 out of 12 of them had silicosis. Lead poisoning, long a serious health hazard in the pottery industry, is now largely under control, due to the substitution of fritted glazes for glazes containing large amounts of readily soluble lead compounds. Five important recommendations based on the expert findings in the survey are given; they are applicable to employers and workers alike. Illustrated. K.R.

Two kinds of dust. L. JAHN. *Tonind.-Ztg.*, **61** [81] 906–907 (1937).—The fact that workers in the lime, cement, and gypsum industry are practically immune to tuberculosis has led to a new method of treatment. W.K.

War may affect U. S. ceramic plants. ANON. *Ceram. Ind.*, **33** [4] 29–34 (1939).—The effects of the European war on the domestic ceramic industry are discussed. Acute shortages of cobalt, nickel, chrome, manganese, and tin are expected. Domestic sources of antimony, selenium, uranium, zirconium, lead, zinc, and titanium compounds should be ample for our needs. English clay imports may be curtailed, resulting in a greater swing toward domestic sources. Dinnerware decals may become very difficult to obtain from foreign sources. Curtailment of imports of finished goods should open up much greater domestic markets as well as those in South America, particularly for whiteware and glass. Domestic production should not suffer because of the war, and sales should be substantially greater. L.M.C.

BOOKS AND SEPARATE PUBLICATIONS

Welfare Problems of Mining Industry. D. HARRINGTON. *U. S. Bur. Mines Information Circ.*, No. 7071, 41 pp. Free.—H. reviews conditions under which miners work; these frequently involve dampness, poor ventilation, and exposure to harmful dusts. An extensive bibliography of the Bureau of Mines publications on the health and welfare of miners is included. R.A.H.

Data on Dust in Industrial Work. D. HARRINGTON. *U. S. Bur. Mines Information Circ.*, No. 7072, 12 pp. Free.—H. gives recommendations to industrialists on how to combat occupational disease hazards from dusts in various industries and cites the recommendations of the Committee of the New York State Department of Labor to the Industrial Commissioner relative to control of toxic gases after blasting in mines, tunnels, and shafts. R.A.H.

Engineering Materials. ALFRED H. WHITE. Edwards. 250 pp. Price $3.00. Reviewed in *Science News Letter*, **36** [4] 64 (1939).—W. lists the properties of materials such as metals, rocks, clays, and silicates. P.G.H.

Engineering Opportunities. Edited by R. W. CLYNE. D. Appleton-Century Co., Inc., New York. 367 pp. Price $3.00. Reviewed in *Science News Letter*, **35** [23] 368 (1939).—Twenty-six fields of industry are described. The book is primarily for the men who are picking out their fields of engineering, but the comments and explanations of the specialists from industry who write the chapters provide a broad summary of modern technology. P.G.H.

Fireproofing Mine Shafts. JOSEPH R. GUITERAS. *U. S. Bur. Mines Information Circ.*, No. 7075, 8 pp. Free.—G. presents data which justify the fireproofing of mine shafts. Fireproofing methods are outlined and examples from practice are given. R.A.H.

Glass Giant of Palomar. DAVID O. WOODBURY. Dodd, Mead & Co., New York, 1939. xiii + 368 pp., 72 illustrations. Price $3.00.—This is a fascinating, intriguing, and readable science book, replete with the human qualities and scientific accomplishments of each and all who have contributed to the making of the giant telescope on Mount Palomar. All great renditions in the fine arts, all accomplishments in science and engineering, all great feats of athletes and orations of statesmen excite in one the wish that he, in a like manner, were accomplished. David O. Woodbury's story of the Glass Giant of Palomar excites in this reviewer the wish that he might as skillfully write a word picture of the advances in a science and of those who have made great contributions to that science. Woodbury's story makes one enthusiastic about astronomy and very personally acquainted with the leading astronomers. We let Woodbury tell of his aim and of how he proceeded.

"A year and a half ago, as I began the research which has led to The Glass Giant of Palomar, it seemed essential to present the story on the basis of the larger truths, subordinating the factual details to the great swing of the whole project. Here was the most magnificent engineering undertaking of our age, an unparalleled example of scientific courage and resourcefulness, a twelve-year adventure in pioneering which included every kind of genius, every shade of persistence, every degree of discouragement and triumph. Only through the recording of these human emotions against the background of the great telescope could the real story of modern science be told. In them lay buried the typical portraits of the men who are bringing knowledge out of the surrounding darkness. To have described the 200-inch Giant in terms of mere facts would have been trivial and insulting. . . .

"Seventy years ago the great romancer Jules Verne told of a gigantic reflecting telescope which was to follow the flight of a projectile fired from the earth to the moon. This fanciful instrument, which he described in full detail, was equipped with a mirror 16 ft. in diameter, weighing 15 tons. . .Eleven years ago Dr. George Ellery Hale, founder of the Mount Wilson Observatory in California, not only bore out Verne's prophecy but improved upon it and began actual construction of a new telescopic giant on Palomar Mountain. Its mirror was to be 17 ft. in diameter, weighing 20 tons; its cost, six million dollars. Not the moon but the very boundaries of space were its objectives. With it Hale hoped to attack such tremendous problems as the shape and size and origin of the universe itself. . .Today, a mile above the Pacific, on the flat top of an isolated mountain in California, the Glass Giant of Palomar is nearing completion. Scarcely a year more and its great aluminum-coated mirror will be turned upon the heavens—a mirror ten thousand times as powerful a gatherer of light as the little lens with which Galileo discovered the moons of Jupiter in 1610 and more than a million times as keen as the human eye. It will reach twice as far into space as the present world's largest telescope, dragging billions of now invisible starts out of obscurity.

"From all over the world glass and steel, manpower and brainpower, and money are converging upon Palomar. Seventy men are working on the mountain today, living there with their wives and children, hammering, sawing, welding, pouring concrete, painting, lining up the huge beams and girders and aluminum sheets which will soon make the observatory shell, higher than a 15-story building. Up the twenty-mile paved road which the county supervisors built especially for the telescope, the largest tractor-trailers in the world are creeping day by day with the parts of the telescope body, shipped into San Diego from eastern factories by way of the Panama Canal. A hundred miles

to the north of Palomar, segregated in a laboratory of its own, the 17-ft. disk of Pyrex glass is gradually being smoothed and polished and tested under the expert hands of twenty-one young men who have 'grown up' with the job. Near by, in another laboratory, a dozen men and women, many of them young, all of them technical experts in every branch of science, are keeping ahead of the Giant's progress with pencil and slide rule and drafting board, solving construction problems, inventing new methods, new machines, new approaches to a job the very magnitude and intricacy of which defies the best engineering practice of the day. . . . Many of the scientists who have coöperated will not live to see the new telescope in service; many more will, in the course of their work, never come into actual contact with it. But in some strange way the instrument is moving surely toward the goal Hale's vision set for it: the rallying point for all brilliant men, the symbol of that magnificent spirit of research once so ably described by Willis R. Whitney: 'The impossible is that which we have not yet learned to do.'

"Such a monument could not be rising if it were not for one man: George Ellery Hale. Dr. Hale gave his life for astronomy and died just when men hate most to die—on the threshold of his greatest achievement. But the story of the world's largest telescope began a long time ago, when Hale began as a child to exhibit scientific genius. And that is how the story must be told, beginning in Chicago in 1881. . . . This is not the typical up-from-the-gutter success story that America loves. George had everything that he needed to give support to his talents: a sturdy New England background, plenty of money for education, sympathetic and intelligent parents, a host of influential friends and associates. In short, the very same equipment which leads thousands of good citizens straight into eclipse as nonenities for sheer lack of economic necessity. But George Hale rose above this level, for his necessity came from within. It was of the spirit. If he did not need wealth, he scorned inaction more. . . .

"Hale got his degree in 1890 (from Massachusetts Institute of Technology), packed up the spectroheliograph (his invention), and went back to Chicago, free now to develop his invention. The astronomers at both Lick and Princeton observatories had heard of his work and offered him the use of large telescopes to aid in his researches. But George decided that he needed an instrument of his own—more than that, a whole observatory which he could devote exclusively to the work on the sun. Again he went to his father and again succeeded in gaining his support. It was some thousands of dollars the elder Hale put up this time—still cheerfully—and the result was a solar laboratory erected in a separate building on the Hale estate in the suburb of Kenwood. Its principal boasts were a 12-inch refracting telescope and a machine shop, small but complete."

"The story of securing funds and instruments for the Yerkes Observatory is a story of the persistance, diplomacy, and ability not alone of Hale but of each and all who contributed to it. The visions and activities not only of the 1922 astronomers but of those who built up the science and technique through the preceding centuries are told most interestingly in Chapter III. Chapter VI gives the history of the Mount Wilson Observatory which reveals those human traits which are needed to accomplish the unaccomplishable, getting tons of instruments and tons of steel and building materials up Mount Wilson on the backs of burros, mules, and especially constructed trucks, and that, too, in the winter, and the negotiations with Carnegie for funds, all with confidence, skill, and hard work. Hale succeeded, and the 60-inch reflector was in service in 1908. And then John D. Hooker virtually forced Hale to make a 100-inch reflector, and Carnegie financed the building of the larger telescope. On goes Woodbury's story of personal dreams and accomplishments until the 200-inch mirror is to be attempted, this time financed by Rockefeller. The many attempts to make this disk out of pure silica are told in detail, showing how great in mind and spirit was not only Dr. Elihu Thomson of General Electric but also the executives of that corporation. Here is a tale of the patience, the daring, and the resourcefulness of a group of scientists and industrialists who would allow of no defeat. That finally they had to abandon the idea of making a 200-inch disk out of pure silica and turn to Pyrex brand glass and the Corning Glass Works is no reflection on the abilities and greatness of Professor Thomson, his colleagues, or the General Electric Company. Then follows the story of making the 200-inch disk out of Pyrex at Corning. In this drama now comes our own George V. McCauley as a star technician. The story of how he finally succeeded is a story of thorough preparation and dogged performance, a very interesting and profitable study of a successful technologist. And with the disk in Pasadena, Woodbury tells of the truck driver who, by years of night study, home practice, and belief in himself, was qualified for the task of grinding the 200-inch disk. A million pounds of glass and steel are the materials, but it is the engineers and scientists upon which Woodbury focuses your attention, among them Marcus Brown, the truck driver, who is in charge of the crew of young men who are grinding and polishing the disk. This is indeed a book which should be read by every person who wants to know by what means he can attain success. He will find that hard work and unselfish collaboration is the formula of success. This is why George Ellery Hale succeeded, and fittingly is the giant observatory on Mount Palomar named the Hale Observatory."

ROSS C. PURDY

Subject Index to Periodicals, 1938. Library Association, London, 1939. xxix + 544 pp. Price 70s. Reviewed in *Nature*, **144** [3643] 372 (1939).—This index is arranged under subject headings in alphabetical order, chosen from the alphabetical subject headings in the Library of Congress, U. S. A., with modifications and additions to suit British practice. The location list included gives information on the periodical holdings of over 170 of the large libraries in the United Kingdom. Verse and fiction are not included. J.L.G.

PATENTS

Ceramic products having metallic characteristics. M. HAUSER. Fr. 827,501, Oct. 5, 1937. D.A.B.

Color coated surfacing material. C. E. HILLERS AND H. L. SMALL (Blue Ridge Slate Corp.). U. S. 2,177,389, Oct. 24, 1939 (Oct. 23, 1936).—A method of coloring granular material comprises coating the granules with barium fluosilicate, an aqueous dispersion of alkali metal silicate, and a coloring agent, heating the granules, soaking the granules in water, rinsing the granules, and finally drying them.

Preparation of seals between ceramic material and metal. T. R. SCOTT AND L. A. C. POOLEY (International Standard Electric Corp.). U. S. 2,175,672, Oct. 10, 1939 (Jan. 7, 1939).—A method of sealing the metallic part of an electrical fitting to a ceramic part thereof comprises providing a filling of a cementing material mainly of styrene between the metal and ceramic parts of the fitting, providing a gasket containing a small amount only of styrene at an exposed surface of the cementing material, and then hardening the cementing material and the gasket by polymerization of the styrene *in situ* to bond to the walls of the electrical fitting parts and to the gasket.

Silicate product and method of making. A. B. CUMMINS (Johns-Manville Corp.). U. S. 2,173,085, Sept. 19, 1939 (April 10, 1931).—(1) In a process of making silicates of a highly porous structure, the steps comprise forming a slurry of alkaline-earth carbonate, finely divided siliceous material, and water, heating the slurry for a prolonged period until the interaction between the carbonate and siliceous material to form a finely divided alkaline earth silicate reaction product is substantially complete, and isolating the silicate product as such from the aqueous medium of the slurry. (8) As an article of manufacture particularly adapted for use as a decolorizing agent, a highly porous alkaline earth silicate reaction product of an alkaline-earth carbonate, finely divided siliceous material, and water, the silicate being a pseudomorph after the alkaline-earth carbonate.

THE AMERICAN CERAMIC SOCIETY TRUSTEES AND OFFICERS FOR 1939–1940

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